

SOLUBILITIES

INORGANIC AND METAL-ORGANIC COMPOUNDS

A - Ir

*A Compilation of Solubility Data
from the Periodical Literature*

VOLUME I

FOURTH EDITION

by

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PREFACE

The first edition of SOLUBILITIES was published in 1907 by Atherton Seidell and contained 353 pages of tables. By 1919 the volume of available data had more than doubled, and a second edition of 756 pages appeared. A supplementary volume in 1928 added 500 pages more. The Third Edition, in 1940, required two volumes totaling more than 2600 pages, and in 1951 the present author joined Dr. Seidell and others in preparing a 1254 page supplement.

The mass of experimental results has continued to grow exponentially. Because of this, certain changes in the methods of compiling and presenting the data have become necessary in this Fourth Edition.

In earlier editions most of the material was gathered through direct searching of the original journals, with little reference to the various abstracts. During the preparation of the 1951 supplement it became evident that the number of original sources was increasing rapidly, and that CHEMICAL ABSTRACTS provided coverage of many journals which otherwise would have been overlooked.

In the present edition, CHEMICAL ABSTRACTS has been used as the starting point for locating all of the new data. The ABSTRACTS were searched, column by column, for articles containing solubility data, and copies of the original publications were then obtained. Inevitably, certain articles were overlooked, and a search of the annual subject indexes increased the number of references by about 10%. Nearly all of the additional (10%) material had been abstracted in sections containing only isolated solubility data, and in articles in which the solubilities were not of major interest. No doubt a fair amount of other, similar data has still been omitted, and the author will welcome any additional material which may be located. One obvious source of data which, unfortunately, is not abstracted, and often is not reprinted in regular journals, is the technical bulletins which are distributed by various chemical manufacturers.

In preparing the tables of data, an attempt has been made to combine, compare, and evaluate the results of the various authors. Less complete, or clearly unreliable data have been omitted, and closely agreeing results often have been plotted and averaged. In addition to making the compilation generally more useful, these techniques have helped reduce the size of the finished volumes.

The Fourth Edition of SOLUBILITIES will consist of three volumes, published at intervals of about a year. The first two volumes will contain inorganic

and metal-organic data, while the third will cover organic compounds. Each volume will include material that has been abstracted through the year preceding its completion. Volume I, completed in 1957, includes material abstracted through 1956, and covers the elements and their compounds, alphabetically, from Argon (A) to Iridium (Ir). Volume II will include material abstracted through 1957, and will complete the alphabetical inorganic tables.

The arrangement of the tables is similar to that used in earlier editions. *Elements are listed alphabetically by their chemical symbol, and their compounds are listed alphabetically according to the chemical symbols of their anions or radicals.* In complex systems, containing several solutes, the data are placed under the solute which is alphabetically earliest. This arrangement tends to place much of the data under the first letters of the alphabet.

For a given compound, the various types of solubility data are arranged in the following order: Solubility in water; in aqueous acids; in aqueous bases; in aqueous salts having a cation in common with the solute; in aqueous salts having an anion in common with the solute; in aqueous salts having no common ion; in aqueous solutions of organic compounds; in anhydrous organic solvents; in anhydrous inorganic solvents; in high temperature mixtures (salt melts).

The Fourth Edition contains, for the first time, a complete compound index, which permits the location of any data without searching the alphabetical tables. Complex systems are listed under each component or solute; double salts and addition compounds are listed under all reasonable variations of the formulas. A cumulative Inorganic and Metal-Organic index will be found at the end of Volume II, which covers all of the material of the first two volumes. The author index is similarly cumulative.

It may be well to remind the reader of the availability of other, more specialized, compilations of solubility, melting point, and general phase equilibrium data. Some of the more important of these are: the International Critical Tables, covering the literature up to about 1927; the Landolt-Börnstein volumes, especially Volume II, part 3 (1956) which is devoted to melting point equilibria of all types; the volume of "Phase Diagrams for Ceramists" published by the American Ceramic Society, covering oxide and silicate melts; the several books listing liquid-vapor equilibria; and the various treatises on the phase rule (such as Ricci: "The Phase Rule and Heterogeneous Equilibrium") which illustrate the principles by extensive reference to the original literature.

The author wishes to express his sincerest appreciation to Dr. Atherton Seidell for his guidance and encouragement throughout the planning of the revision. Thanks are also extended to Dr. M.J.D. Low, Mr. Jack Morrow, and Miss G. Blumenscheidt for help in abstracting and indexing. Finally, I wish to thank my wife, Ruth, for her patience and assistance at every stage of the compilation. Her help has indeed made possible the completion of this first volume.

William F. Linke

ARGON A

THE SOLUBILITY OF ARGON IN WATER

The data of Lanning, 1930 (0°-40°), Morrison and Johnstone, 1954 (10°-80°), Friedman, 1954 (15°, 25°), and Eucken and Hertzberg, 1950 (0°, 20°) are in excellent agreement. The values listed below were read from a smooth curve drawn through the combined data. The average deviation of the original data from the curve is 0.0002.

The results of various earlier workers were not in agreement with each other and were up to 20% higher than these. For earlier work, see: Ramsey, 1895; Estricher, 1899; Winkler, 1897, 1905; Von Antropoff, 1910, 1919; Valentiner, 1927, 1930; Akerlof, 1935; Behnke and Yarbrough, 1939.

α = Bunsen adsorption coefficient. α = ml. of gas (measured at S.T.P.) dissolved by 1 ml. of solvent when the partial pressure of the gas is 1 atmosphere. See page 2.

°C	α	°C	α	°C	α
0	0.0528	30	0.0288	60	0.0209
5	.0466	35	.0269	65	.0202
10	.0413	40	.0251	70	.0196
15	.0370	45	.0237	75	.0189
20	.0337	50	.0226	80	.0184
25	.0311	55	.0217		

SOLUBILITY OF ARGON IN WATER AT HIGH PRESSURES AT 0.2°
(Sisskind and Kasarnowski, 1931)

	Partial pressure of argon (atm.)				
	25	50	75	100	125
Bunsen coefficient α	0.0516	0.0504	0.0467	0.0435	0.0405
Ml. A (at STP) dissolved in 1 ml. H ₂ O ($\alpha \times P$)	1.29	2.52	3.50	4.35	5.06

SOLUBILITY OF ARGON IN SOLUTIONS OF ELECTROLYTES

The data of Eucken and Hertzberg, 1950 (EH) and Morrison and Johnstone, 1955 (MJ) are in reasonable agreement; those of Akerlof, 1935 (UNMARKED) are considerably higher. Akerlof's reference value for the solubility in pure water is also high (compare with above). Morrison and Johnstone reported only Setschenow ("salting out") coefficients [$k = \frac{\log S_0/S}{C}$ where S_0 = soly. in H₂O, S = soly. in salt solution of concentration C moles per 1000 gms. H₂O,] from which α values were calculated.

A ARGON

Salt	°C	Moles salt per 1000 gms. H ₂ O	α	Salt	°C	Moles salt per 1000 gms. H ₂ O	α
(NONE)	25°	(0)	(0.0332)				
NaCl	0°	0.43	0.0443 EH	KCl	25°	3.00	0.0220
		1.005	.0343 EH			4.55	0.0174
		1.07	.0337 EH	KI	25°	1	0.0243 MJ
		2.26	.0208 EH			3	.0148 MJ
		3.46	.0147 EH			6	.0070 MJ
	20°	0.54	0.0277 EH	NaNO ₃	25°	3.51	0.0204
		1.13	.0225 EH			7.37	.0123
		1.91	.0170 EH	MgCl ₂	25°	3.02	0.0248
	25°	1	0.0229 MJ			5.02	.0228
		2	.0169 MJ	CaCl ₂	25°	2.95	0.0216
		3	.0124 MJ			5.37	.0180
		3.23	.0216	SrCl ₂	25°	2.10	0.0203
		5.98	.0149			3.56	.0150
LiCl	25°	6	.0050 MJ	BaCl ₂	25°	1.25	0.0185
		1	0.0249 MJ			1.74	.0141
		3	.0160 MJ	AlCl ₃	25°	0.98	0.0247
		3.35	.0248			1.56	.0179
		6.78	.0187	HClO ₄	25°	4.05	0.0411

SOLUBILITY OF ARGON IN ORGANIC SOLVENTS AT VARIOUS TEMPERATURES AND PRESSURES

[(Sisskind and Kasarnowski, 1931, 1933; Lannung 1930 (*);
Cauquil, 1927 (**); Friedman, 1954 (***)]

The values of α (Bunsen adsorption coefficient) listed below are the ml. of argon (measured at S.T.P.) which dissolve in 1 ml. of solvent per atmosphere of partial pressure of argon. To obtain the ml. of gas (measured at S.T.P.) which will dissolve at the T and P of the experiment, multiply α by the pressure of argon. For example, in methyl alcohol (see below) $\alpha = 0.310$ at 0.2°, 25 atm. Therefore $0.310 \times 25 = 7.75$ ml.(S.T.P.) will dissolve in 1 ml of methyl alcohol under these conditions.

SOLUBILITY OF ARGON IN ORGANIC SOLVENTS AT VARIOUS TEMPERATURES
AND PRESSURES--Contd.

Solvent	°C	P.P. Argon (Atm.)	α	Solvent	°C	P.P. Argon (Atm.)	α
Methyl Alcohol	0.2	1	0.262	Acetone	0	25	0.238
	0.2	25	0.310		0	50	0.249
	0.2	50	0.325		0	100	0.254
	0.2	75	0.317		15	1	0.271*
	0.2	100	0.309		18	1	0.271*
	15	1	0.253*		20	1	0.273*
	18	1	0.251*		25	1	0.274*
	20	1	0.250*		30	1	0.276*
	25	1	0.245*		37	1	0.279*
	30	1	0.243*	Methyl Ethyl			
	37	1	0.240*	Ketone	0	25	0.222
Ethyl Alcohol	0.2	1	0.251				(0.239)
	0.2	25	0.303	Methyl Propyl			
	0.2	50	0.315	Ketone	0	50	0.234
	0.2	75	0.304	Diethyl Ketone	0	50	0.237
	0.2	100	0.275	Methyl Hexyl			
	15	1	0.243*	Ketone	0	50	0.193
	18	1	0.242*	Ethyl Propyl			
	20	1	0.240*	Ketone	0	50	0.238
	25	1	0.237*	Cyclohexanone	0	50	0.127
	30	1	0.234*	"	0	100	0.128
	37	1	0.231*	"	25	50	0.124
n Propyl				Benzene	7	50	0.197
Alcohol	0	50	0.220	"	7	100	0.203
n Butyl				"	7	125	0.204
Alcohol	0	50	0.209		15	1	0.220*
Iso Butyl					18	1	0.221*
Alcohol	0	50	0.228		20	1	0.221*
Sec. Butyl					25	1	0.222*
Alcohol	0	50	0.210		30	1	0.222*
Iso Amyl					37	1	0.222*
Alcohol	0	25	0.210	Toluene	0	25	0.200
Iso Amyl				"	0	50	0.200
Alcohol	0	50	0.210	"	0	75	0.214
n Hexyl				"	7	50	0.195
Alcohol	0	25	0.174	Xylene	0	50	0.196
			(0.190)				(0.205)
n Octyl				"	0	100	0.211
Alcohol	0	50	0.163	Cyclohexane	15	1	0.380*
Sec. Octyl					18	1	0.307*
Alcohol	0	25	0.172		20	1	0.306*
Benzyl					25	1	0.305*
Alcohol	0	25	0.060		25	50	0.302
Benzyl					30	1	0.304*
Alcohol	0	50	0.060		37	1	0.303*
Cyclohexanol	25	1	0.112*	Methyl			
	25	50	0.112	Cyclohexane	25	50	0.311
	26	1	0.171(?)**	Petane	0	25	1.32
	30	1	0.113*	Nitromethane	24.85	1	0.0133***
	37	1	0.114*	Nitromethane			
Ethyl ether	0	25	0.554	saturated with			
Benzyl ether	0	25	0.068	H ₂ O	24.85	1	0.0128***
	0	50	0.069	H ₂ O saturated			
	0	100	0.072	with			
Benzaldehyde	0	25	0.106	Nitromethane	24.85	1	0.0290***

Ac ACTINIUM

MISCELLANEOUS DATA ON THE SOLUBILITY OF ARGON

<u>Solvent</u>	
OLIVE OIL	At 22°, α = 0.15 (Loomis, 1946; Nasini and Corinaldi, 1932) At 37°, α = 0.14 (Loomis, 1946)
MOLTEN PARAFFIN WAX	At 72.2°, α = 0.159; physical properties of wax; M.P. 50.4°, M.W. = 350, density 68.3° = .7716, 76.8° = 0.7662 (Ridenour, Weatherford, Jr., and Capell, 1954)
SEA WATER	2-28°, 15-21 gms Cl ⁻ /Kg. sea water [Solubility of "Total Inert Gases in the Atmosphere"] (Rakestraw and Emmel, 1938)
SEA WATER	Including a critical discussion of the literature (Coste, 1917)
Solubility of Solid Argon:	
LIQUID OXYGEN	Temp °K Mole fraction Argon
	72.30° 0.558
	75.99° .668
	77.20° .734
	79.09° .802
	82.09° .927 (Inglis, 1906)
(Fastovskii and Krestinskii, 1942)	
OXYGEN, METHANE, KRYPTON	Solid-liquid equilibria (Veigh and Schroder, 1937)
OXYGEN, METHANE, NITROGEN	Solid-liquid equilibria (Federova, 1939)
NITROGEN	Solid-liquid equilibria (Bridgmen, 1934; Robinson, 1954)
SOLID AND LIQUID METALS	Solubility and diffusion (Sieverts and Bergner, 1912)
PALLADIUM	Activated by thermic treatment in a vacuum absorbs 319 volumes of argon (Klarmann, 1930).

Ac ACTINIUM COMPOUNDS

SEPARATION OF ACTINIUM FROM LANTHANUM OXIDES (Perry, 1949)

0.400 gms of La₂O₃ containing 1 millicune of actinium were dissolved in 60% acetic acid (by volume) and ammonia was added to precipitate the oxides. Addition of ammonium acetate increased the solubility of actinium oxide more rapidly than that of lanthanum oxide and when 60 gms of NH₄Ac per gm La₂O₃ were present, none of the actinium precipitated, while 65% of the lanthanum did so. By repeating the precipitation four times, an eighty-fold concentration was obtained, yielding 0.002g La₂O₃ containing 0.4 milliaines of actinium. The temperature was 15° ± 2°.

EXTRACTIONS FROM SOLUTIONS OF THORIUM NITRATE

Experiments are described by Imre, 1927, upon the separation of RaAc by means of distribution studies. Since iron can be removed from its hydrochloric acid solution by extraction with ether, this principle was applied to the separation of RaAc. Nitric acid was substituted for hydrochloric acid. Results are given for the extraction of aqueous nitric acid solutions of thorium by means of ether, and similar results for nitric acid actinium solutions. This method failed to separate RaAc into two components, thus furnishing new evidence of its unity.

SOLUBILITY OF ACTINIUM EMANATIONS IN SEVERAL SOLVENTS
(Hevesy, 1912)

A method was elaborated for determining the partition coefficient between a gas and a liquid phase. The solubility of actinium emanations was then determined in KCl, H₂O, H₂SO₄, C₂H₅OH, (CH₃)₂CO, C₆H₅CHO, C₆H₆, C₇H₈, petroleum ether and CS₂. The solubility increases in the order named. Close relations are indicated between actinium, thorium and radium.

SILVER Ag

Ag

SOLUBILITY OF METALLIC SILVER IN WATER

The determinations of Krépelka and Toul (1929), Freudlick and Söllner (1928), and Pariand and Archinard (1954) are in good agreement. Krépelka and Toul used thin leaves of silver "sufficiently pure for atomic weight work" and kept the flasks in the dark. Pariand and Archinard used a "thoroughly degassed, electrolytically pure" pulverized sample. In all cases the water was highly purified, neutral, and degassed. Analyses were made by (1) evaporation in quartz in the dark (K. and T.), (2) extraction with chloroform and dithizone (P. and A.), (3) Haber's (etal.) 1926, microscopic method (F. and S.).

t° mg Ag per liter		
18-20	0.035	(maximum soly; reached after 21 days) Krépelka and Toul, 1929
Room	.025	(after 3 days contact) Freudlich and Söllnor, 1928
25-28	.028	(maximum soly; reached after 18 days) Pariand and Archinard, 1954

Krépelka and Toul found that the solubility determined in silver flasks averaged 0.003 mg less than that in glass. The difference is "probably due to the influence of alkalis dissolved from the glass." FURTHER, they found that silver sheets, the surface of which had been previously reduced by pure hydrogen at 400 showed no solubility as measured nephelometrically. They conclude that the dissolution of silver is caused by its surface oxide, adsorbed oxygen, or oxygen dissolved in the water.

Ag ARGENTUM

SOLUBILITY OF SILVER IN AQUEOUS SOLUTIONS

SOLUBILITY OF SILVER IN POTASSIUM IODIDE SOLUTION (Toporescu, 1940)

The author placed silver blocks into a solution containing 50 gms of potassium iodide per 100 gms of solution, and allowed them to stand from 10 to 14 days at room temperature. The silver was then removed and a large volume of water was added to precipitate the silver iodide which had formed.

Days contact	pH		Gms Agl per 10 cc solution
	Initial	Final	
10	5.8	8.3	0.0358
12	5.8	8.8	.0386
14	5.8	10.5	.0522

8.83 mg. of silver dissolve in 100 ml. of a solution which is 0.5% thiourea, 1% H_2SO_4 , and 0.06% H_2O_2 . (In twelve hours) If 1 gm. of iron chloride is substituted for the H_2O_2 , at least 10.04 mg. silver dissolve. (Plaksin and Kozhuchova 1941.)

Plaksin and Shibaev (1936) determined the rate of solution of silver and various silver-gold and silver-copper alloys in KCN solutions as a function of concentration.

Plaksin and Shabavin (1940) give data for the solubilities of silver-gold alloys in potassium cyanide solutions of various strengths, alone and in the presence of hydrogen peroxide.

For equilibrium between metallic silver and mercury (silver amalgam) and mixed aqueous solutions of their nitrates, determined for mixtures of the two metals in all proportions, see Reinders, 1906.

SOLUBILITY OF SILVER IN METALS AND SALTS

SOLUBILITY OF SILVER IN MERCURY (Sunier and Hess, 1928; DeRight, 1933; Hudson, 1945)

From 10° to 200° highly purified Hg and excess of pure Ag were agitated together by gentle rocking in an evacuated tube provided with a side bulb into which the saturated solution could be filtered through glass wool by inverting and allowing air to enter the apparatus. Equilibrium was approached from both sides at each temperature. The analyses were made by distilling the mercury from the filtered saturated solution at 200° under vacuum or by volatilizing it in a stream of hydrogen at 270°-300°, and weighing the residual silver.

Above 200° (Hudson), silver and mercury were sealed together in a glass tube which was then suspended in a constant temperature vapor bath for varying periods of time. Knowing the total weight, analyses were made by determining the loss in weight of the solid silver core after the mercury was removed from it by distillation. Hudson also gives data

above the boiling point of mercury, and Murphy, 1931 has investigated the system up to the melting point of silver.

The results are expressed in terms of gram atoms of Ag per 100 gram atoms of Ag + Hg.

t°	Atomic Percent Ag	t°	Atomic Percent Ag	t°	Atomic Percent Ag	t°	Atomic Percent Ag
10	0.048	70	0.241	160	1.053	260	3.45*
20	0.066	80	0.288	180	1.356	280	4.20*
30	0.088	90	0.352	200	1.708	300	5.01*
40	0.114	100	0.419	200	1.80*	320	5.88*
50	0.147	120	0.587	220	2.33*	340	7.14*
60	0.190	140	0.797	240	2.86*	356.7	9.29*

*Hudson

Data for the solubility of silver in copper from hardness measurements are given by Hanson, 1930; from x-ray studies by Agnew and Sachs, 1930.

Data for the distribution of silver between two phases:

Between Zn + Pb	} Tanmann & Schaftmeister, 1924
" Zn + Bi	
" Al + Pb	
" Al + Bi	
" Zn + Tl	
" Al + Tl	} (theoretical estimations) Jellinek, 1944
" Sn + SnCl ₂ at 910° (Ag _{Sn} /Ag _{SnCl₂} ≈ 4) Anderson & Ridge, 1943	
" Bi + BiF ₃	
" Pb + PbF ₂	

Ternary reciprocal systems:

Ag + CuCl	\rightleftharpoons AgCl + Cu	at 1000°	} Jellinek & Siewers, 1932
Ag + CuBr	\rightleftharpoons AgBr + Cu	at 1000°	
4Ag + Pb ₂ P ₂ O ₇	\rightleftharpoons Ag ₄ P ₂ O ₇ + 2Pb	at 1200°	
2Ag + PbI ₂	\rightleftharpoons 2AgI + Pb	at 800°	} Hewsky & Jellinek, 1933
2Ag + PbCl ₂	\rightleftharpoons 2AgCl + Pb	at 800°	
Ag + CuCl	\rightleftharpoons AgCl + Cu	} Tubanut & Munzing, 1927	
2Ag + PbCl ₂	\rightleftharpoons 2AgCl + Pb		
Ag + PbS	}	} Vogel & Gube, 1953	
2Ag + PbS			\rightleftharpoons Ag ₂ S + Pb
3Ag + BiCl ₃	\rightleftharpoons 3AgCl + Bi	Sokolova, 1952	

Ag + Ag₂O (Eutectic ≈ 51mole%Ag₂O, 500°)? Hennig, 1955

Ag + Ag₂O (Max. soly Ag in Ag₂O = 4%)? Faivre, 1940

Ag ARGENTUM

AsO SILVER ARSENITE Ag_3AsO_3

One liter H_2O dissolves 0.0115 gm. Ag_3AsO_3 at 20° . (Whitby, 1910).

[The determinations of Whitby were made by a colorimetric method which was based upon the observation that the color produced by heating a solution of a silver salt with sodium hydroxide and certain organic compounds such as dextrine, starch, sugar etc., is proportional to the amount of silver present.]

SILVER ARSENATE Ag_3AsO_4

One liter H_2O dissolves 0.0085 gm. Ag_3AsO_4 at 20° . (Whitby, 1910).

On the basis of a study of the reaction $\text{Ag}_3\text{AsO}_4 + 3\text{AgCl}$ at room temperature ($K = 9.34 \times 10^7$), Tananaev and Lovi (1942) found the solubility product of silver arsenate to be 1.08×10^{-22} . This leads to a solubility of 0.00065 gms. per liter, assuming the reaction $\text{Ag}_3\text{AsO}_4 \rightleftharpoons 3\text{Ag}^+ + \text{AsO}_4^{3-}$.

BO SILVER BORATE AgBO_2

One liter of aqueous solution contains about 9.05 gms. AgBO_2 at 25° . (Abegg and Cox, 1903).

SILVER TETRABORATE $\text{Ag}_2\text{B}_4\text{O}_7$

EQUILIBRIUM IN THE SYSTEM $\text{Ag}_2\text{O} - \text{B}_2\text{O}_3 - \text{H}_2\text{O}$ AT 19°
(Rollet, 1930)

Gms. per 100 gms. Sat. Solution		Solid Phase	Gms. per 100 gms. Sat. Solution		Solid Phase
Ag_2O	B_2O_3		Ag_2O	B_2O_3	
0.16	0.1	$\text{Ag}_2\text{B}_4\text{O}_7 \cdot 2\text{H}_2\text{O}$	0.91	3.51	$\text{Ag}_2\text{B}_4\text{O}_7 \cdot 2\text{H}_2\text{O} + \text{H}_3\text{BO}_3$
0.22	0.75	"	0.70	3.3	H_3BO_3
0.33	1.4	"	0.35	2.9	"
0.55	2.2	"	0.0	2.6	"

SILVER Tri Antipyrine BORO FLUORIDE $\text{Ag}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_3\text{BF}_4$

100 cc sat. solution in H_2O contain 17.7 gms. salt at 20° . (Wilke-Dorfurt and Mureck, 1929).

SILVER BROMIDE AgBr

Br

SOLUBILITY OF SILVER BROMIDE IN WATER

The determinations of Gledhill and Malan, 1953, 1954 are in very good agreement with those of Harned, Keston, and Donelson, 1936 which were recalculated by Pouradier, Venet and Chateau, 1954. The values of Uryu, 1951 agree at 10°-15° and 45°-50°, but between these temperatures average 0.00004 higher. The values of Bedell, 1938 (20°-80°) are too high because they depended on observation of the formation of a precipitate. The data of Hahn and Schulze, 1927, Kolthoff, 1921, and Masaki, 1930 (all at 18°), Vouk, Kratochvil and Tezak, 1953 at 20°, Ruka and Willard, 1949 and Hill, 1908 at 25° all seem too high and do not agree with each other. The data above 200° are those of Gavrish and Galinker, 1955. These authors found the value 0.000084 at 20°C. Most workers have used potentiometric or conductimetric methods.

Data of Gledhill and Malan, 1953, 1954; Harned, Keston and Donelson, 1936; Bottger, 1900; and Gavrish and Galinker, 1955.

°C	gms. AgBr per liter	°C	gms. AgBr per liter	°C	gms. AgBr per liter
5	0.000041 GM	40	0.000293 HKD	269	0.131 GG
15	.000072 GM	45	.000398 GM	289	.136 GG
20	.000097 HKD	50	.000477 HKD	299	.149 GG
25	.000135 GM	55	.000665 GM	309	.156 GG
	.000130 HKD	60	.000746 HKD	319	.157 GG
30	.000180 KHD	100	.00370 B	329	.165 GG
35	.000237 GM			334	.167 GG
				339	.179 GG
				349	.249 GG

Earlier work in reasonable agreement with these data are those of at 20° of Böttger, 1903 (0.000084); at 25° of Goodwin, 1894 (0.000125), Owen and Brinkley, 1938 (0.000132); Abegg and Cox, 1903 (0.000137), Thiel, 1900 (0.000152), Koch, 1930 (0.000146).

SOLUBILITY OF SILVER BROMIDE IN HYDROBROMIC ACID SOLUTIONS
(Dede and Walther, 1927; Erber, 1941*)

t°	Solvent		Saturated solution		
	Wt. % HBr	Density _{4°} ^{t°}	Wt. % HBr	Wt. % AgBr	Density _{4°} ^{t°}
0*	47.8	1.501	46.5	2.68	1.533
	40.1	1.389	39.5	1.41	1.404
	38.9	1.374	38.5	1.26	1.388
	34.8	1.322	34.6	0.77	1.331
	26.8	1.230	26.7	.22	1.232
	21.1	1.174	21.1	.072	1.175
	14.7	1.115	14.7	.018	1.116
20	31.0	-	30.8	0.492	-
	18.3	-	18.3	.0558	-
	13.0	-	13.0	.0184	-

Ag ARGENTUM

t°	Solvent		Saturated solution		
	Wt. % HBr	Density ^{t°} ₄	Wt. % HBr	Wt. % AgBr	Density ^{t°} ₄
25*	47.8	1.484	46.4	2.95	1.520
	40.1	1.376	39.5	1.58	1.393
	38.9	1.360	38.4	1.40	1.375
	36.7	1.332	36.3	1.08	1.344
	32.2	1.279	32.0	0.59	1.285
	26.8	1.221	26.7	.26	1.223
	21.1	1.166	21.1	.11	1.167
	14.7	1.109	14.7	.030	1.109
Br 40	31.0	-	30.8	0.579	-
	18.3	-	18.3	.0795	-
	13.0	-	13.0	.0275	-
60	31.0	-	30.7	0.693	-
	18.3	-	18.3	.115	-
	13.0	-	13.0	.0452	-
80	31.0	-	30.7	0.865	-
	18.3	-	18.3	.168	-
	13.0	-	13.0	.0699	-

SOLUBILITY OF SILVER BROMIDE IN NITRIC AND SULFURIC ACID SOLUTIONS

Ruka and Willard 1949 determined the solubility of AgBr in 0.03 - 1.0 N HNO₃ solutions and found no variation with HNO₃ concentration. The precision of their data (by radioactive tracer technique) was poor. They found 0.0003 gms. per liter dissolved at 0° and 0.0001 gm. per liter at 25°.

Data were also obtained by Bedell, 1938 at about 20°, by observing the point of precipitation of AgNO₃ + HBr and Ag₂SO₄ + HBr solutions. Only very slight increases in solubility were observed.

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS AMMONIA SOLUTIONS

(0° Jarry, 1899; 12° Longi, 1883; 15° Bodländer, 1892; 25° Bodländer and Fittig, 1901-02, also Whitney and Melcher, 1903 (*); 80° Pohl, 1860)

	Gms. per liter Saturated Sol'n.			Gms. per liter Saturated Sol'n.	
	NH ₃	AgBr		NH ₃	AgBr
0°	30.7	0.80	0°	262.7	10.67
	48.8	0.96		312.6	15.68
	66.9	1.72		388.9	19.87
	82.9	2.12		365.2	26.69
	115.1	3.49		372.2	28.88
	153.2	5.57		377.0	29.30
	180.9	7.22		392.6	28.92
	195.3	7.41		399.5	28.52

	Gms. per liter Saturated Sol'n.		$d_{15.5}$ of Sat'd. Sol'n.	Gms. per liter Saturated Sol'n.		
	NH ₃	AgBr		NH ₃	AgBr	
12°	5 100	0.114 3.33		25*	4.56 4.65 6.58 7.66 8.46 13.0 34.0 52.8 93.0	.177* .201* .226 .319* .300* .422 1.32 2.24 4.78
15°	18.48 40.28 58.07 78.17 97.50	0.42 1.16 1.88 2.78 3.80	0.9932 .9853 .9793 .9720 .9655			
25°	1.30 1.96 3.30	0.052* .073* .113		80°	32.5	0.5 (dried AgBr) 1.0 (freshly pptd)

Br

SOLUBILITY OF SILVER BROMIDE IN 1 MOLAR AMMONIA SOLUTIONS,
CONTAINING VARYING AMOUNTS OF POTASSIUM BROMIDE
(Lyalikov and Piskunova, 1954)

moles/liter KBr	moles AgBr per liter		
	25°	35°	45°
0.01	0.00120	0.00134	0.00222
.02	.00069	.00084	.00120
.03	.00052	.00066	.00090
.04	.00043	.00054	.00080
.05	.00038	.00047	.00072
0.1	.00027	.00033	.00058
.2	.00030	.00033	.00058
.4	.00030	.00038	.00052
.8	.00058	.00069	.00081
1.6	.00258	.00248	.00375

SOLUBILITY OF SILVER BROMIDE IN SOLUTIONS OF METHYLAMINE AND ETHYLAMINE

(15°-Jarry, 1899; 25°-Bödländer and Eberlein, 1903 also Wuth, 1902
(*). The results of the Bödländer & Eberlein do not agree well with
those of Wuth.

(over)

Ag ARGENTUM

Methylamine				Ethylamine	
11.5°		25°		25°	
Gms. per liter	Sat. Sol.	Gms. per liter	Sat. Sol.	Gms. per liter	Sat. Sol.
CH ₃ NH ₂	AgBr	CH ₃ NH ₂	AgBr	C ₂ H ₅ NH ₂	AgBr
110.1	0.7	31.6	0.47	21.8	0.434
131.7	1.2	15.8	.24	9.02	.182
151.3	1.6	6.30 ^a	.092*	4.51	.0892
179.7	2.8	3.17	.049	4.64	.1336*
325.8	5.5	2.9 ₄	.077*	2.960	.0485*
356.2	7.3	1.5 ₈	.023	2.485	.0362*
Br 431.1	12.7	1.2 ₄	.064*	1.777	.0257*
484.4	28.9	0.6 ₂	.049*	0.574	.0163*

^aat this concentration of CH₃NH₂ Böldlander and Eberlein agree with Wuth.

SOLUBILITY OF SILVER BROMIDE IN SILVER NITRATE SOLUTIONS AT 20° (Vouk, Kratochvil & Tezak, 1953)

AgNO₃ was added to KBr solutions until the turbidity of AgBr disappeared. The data are the molarities of KBr and AgNO₃ in the solution at the point of disappearance of the solid. Thus the solubility of AgBr is equal to the KBr molarity, and the solvent may be considered an AgNO₃ solution containing a trace of KNO₃ (equal to the AgBr concentration).

moles per liter Sat. Sol.		moles per liter Sat. Sol.		moles per liter Sat. Sol.	
KBr (AgBr)	AgNO ₃	KBr (AgBr)	AgNO ₃	KBr (AgBr)	AgNO ₃
0.000001	0.115	0.000025	0.57	0.0006	1.68
.0000015	.145	.000040	.69	.001	2.01
.0000025	.215	.000060	.75	.0015	2.25
.0000040	.25	.0001	.93	.0025	2.76
.0000060	.315	.00015	1.08	.0021	3.0*
.00001	.42	.00025	1.29	.004	3.15
.000015	.48	.00040	1.44	.006	3.45
				.01	4.05

*Hellwig, 1900

SOLUBILITY OF SILVER BROMIDE IN POTASSIUM BROMIDE SOLUTIONS

The data of Hellwig, 1900; Dede and Walther, 1927; Chateau and Pouradier, 1952; Vouk, Kratochvil and Tezak, 1953; Pouradier, Venet and Chateau, 1954; and Lyalikov and Piskunova, 1954 are in good agreement. Further data for the solubility in bromide solutions is given by Berne and Leden, 1953.

(Dede and Walther, 1927)

°C	Solvent wt. % KBr	Sat'd. Soln. wt. %		°C	Solvent wt. % KBr	Sat'd. Soln. wt. %	
		KBr	AgBr			KBr	AgBr
20	18.0	18.0	0.0304	60	18.0	18.0	0.0638
	24.8	24.8	0.119		24.8	39.1	0.193
	39.8	39.3	1.37		39.8	39.1	1.68
40	18.0	18.0	0.0433	80	18.0	18.0	0.0950
	24.8	24.8	0.148		24.8	24.8	0.264
	39.8	39.2	1.49		39.8	39.0	1.96

Data read from the graphs given by Pouradier, Venet and Chateau, 1954: Br

moles AgBr per liter			
moles KBr per liter:	0.316	1.0	3.16
20°	0.000025	0.00032	0.016
30°	.000035	.00045	.018
40°	.000045	.00056	.022
50°	.000063	.00071	.025
60°	.000089	.00089	.027

Data of Vouk, Kratochvil, and Tezak, 1953; Hellwig, 1900 (*); at 25° and of Lyalikov and Piskunova, 1954 (**) at room temperature:

Vouk, Kratochvil and Tezak added KBr to AgNO₃ solutions until the turbidity of AgBr disappeared. The data are the molarities of KBr and AgNO₃ in the solution at the point of disappearance of the solid. Thus the solubility of AgBr is equal to the AgNO₃ molarity and the solvent may be considered a KBr solution containing a trace of KNO₃ (equal to the AgBr concentration).

moles per liter Sat. Sol.		moles per liter Sat. Sol.		moles per liter Sat. Sol.	
KBr	AgBr	KBr	AgBr	KBr	AgBr
0.00000025	0.000004	0.15	0.000060	2.14	0.0040
.000001	.000001	.195	.000010	2.32	.0060
		.198	.000011**		
.0000025	.0000004	.265	.000020	2.70	.010
		.385	.000039**		
.0000040	.00000025	.40	.000040	2.76	.0117*
				2.79	.0128**
.000010	.00000010	.465	.000060	3.118	.020
.001	.00000010	.60	.00010	3.332	.025
		.784	.00030**		
.011	.0000004	.83	.00020	3.548	.040
.0275	.0000010	1.00	.00040	3.68	.0399*
.048	.0000015	1.17	.00060	4.18	.0719*
.0825	.0000025	1.38	.0010	4.44	.0957*
.099	.000006**	1.434	.00104**		
.115	.0000040	1.73	.0020	4.864	.1409*
				4.915	.132**

Lyalikov and Piskunova also give data at constant ionic strengths.

Ag ARGENTUM

SOLUBILITY OF AgBr IN NaBr SOLUTIONS AT 20° (Kratohvil and Tezak, 1954)

The method was the same as that used by Vouk, Kratohvil and Tezak (above) for KBr solutions. Small amounts of NaNO_3 (equal to AgBr) are also present.

	moles per liter Sat. Soln.		moles per liter Sat. Soln.		moles per liter Sat. Soln.	
	NaBr	AgBr	NaBr	AgBr	NaBr	AgBr
Br	3.335	0.01	1.38	0.0006	0.425	0.00004
	2.875	.006	1.173	.0004	.29	.00002
	2.575	.004	0.922	.0002	.195	.00001
	2.07	.002	.667	.0001	.15	.000006
	1.61	.001	.52	.00006	.115	.000004

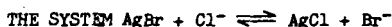
SOLUBILITY OF SILVER BROMIDE IN AMMONIUM BROMIDE SOLUTIONS AT ROOM TEMPERATURE (Lyalikov and Piskunova, 1950)

Sat'd. Sol'n. moles per liter		Sat'd. Sol'n. moles per liter	
NH_4Br	AgBr	NH_4Br	AgBr
0.1	0.000004	1.420	0.00114
.198	.000011	2.773	.0133
.294	.000020	4.909	.152
.384	.000039	6.440	.427
.794	.000196		

Data are also given at constant ionic strengths. For further data see Winther 1923, 1924 who measured the solubility product of AgBr in NH_4Br , NH_4Br , NH_4Cl , NH_4I , gelatine, and erythrosine solutions (potentiometrically) and obtained a mean value of 1.23×10^{-12} .

SOLUBILITY OF SILVER BROMIDE IN CALCIUM BROMIDE SOLUTIONS (Dede and Walther, 1927)

t°	Solvent wt.% CaBr_2	Sat'd. Sol'n. wt.%		t°	Solvent wt.% CaBr_2	Sat'd. Sol'n. wt.%	
		CaBr_2	AgBr			CaBr_2	AgBr
20	15.6	15.6	0.0194	60	15.6	15.6	0.0468
	21.7	21.7	.0678		21.7	21.7	.130
	35.7	35.5	.625		35.7	35.4	.873
40	15.6	15.6	.0299	80	15.6	15.6	.0735
	21.7	21.7	.0909		21.7	21.7	.182
	35.7	35.5	.738		35.7	35.4	1.064



The equilibrium between solid solutions of AgBr and AgCl and solutions containing varying amounts of Cl^- and Br^- ion was studied by Küster, 1899 at 19° and by Yutzy and Kolthoff, 1937 at 27° and 98°. Varying volumes of AgNO_3 , KBr and NaCl solutions were mixed, and equilibrium was approached from different directions. The data yield the

distribution coefficient of Br^- between solution and solid. The crystal structures of the continuous solid solutions obtained by mixing solutions at 80° were determined by Raynaud, Duranté, Hervier and Pouradier, 1955—100 gms. of a solution containing 21 wt. % NaCl will dissolve 0.038 gm. of AgBr at 15° (Schierholz, 1890).

SOLUBILITY OF SILVER BROMIDE IN SODIUM THIOSULFATE SOLUTIONS

20° (Valenta, 1894; Recalc'd. by Cohn, 1895)			35° (Richards and Faber, 1899)		Br
Solvent gms. AgBr: gms. H ₂ O	gms. AgBr per 100 gms. solvent		Solvent gms. Na ₂ S ₂ O ₃ per liter	gms. AgBr per liter of solvent	
	Valenta	Cohn			
1:100	0.35	0.50	63.8	37.6	
5:100	1.90	2.40	127.5	78.0	
10:100	3.50	4.59	191	119.1	
15:100	4.20	6.58	255	170.8	
20:100	5.80	8.40			

"At room temperature(?) 2.06 gms. AgBr dissolve in a liter of 1% $\text{Na}_2\text{S}_2\text{O}_3$ " (Mees and Piper, 1912).

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF MERCURIC NITRATE AT 25° (Morse, 1902)

Mols. HgNO_3 - (HNO_3) per Liter	Mols. AgBr per Liter	Gms. AgBr per Liter	Mols. HgNO_3 - (HNO_3) per Liter	Mols. AgBr per Liter	Gms. AgBr per Liter
1.00	0.03660	6.878	0.025	0.00459	0.863
0.10	0.00873	1.640	0.0125	0.00329	0.618
0.05	0.00639	1.200	0.0100	0.00306	0.575

Since HNO_3 was present in all cases, its influence on the solubility was examined. It was found that no appreciable differences were obtained with concentrations varying between 0.1 and 2 normal HNO_3 . Both crystallized and amorphous silver bromide gave identical results.

Data for the increased solubility of AgBr in $\text{Hg}(\text{NO}_3)_2$ and HgSO_4 solutions are also given by Bedell, 1930 who mixed solutions until a precipitate was observed.

SOLUBILITY OF SILVER BROMIDE IN SODIUM SULFITE SOLUTIONS (Jahn and Staude, 1951; Luther and Leubner, 1912a (*); Mees and Piper, 1912**)

The experiments of Jahn and Staude were done in a nitrogen atmosphere.

Ag ARGENTUM

t°	moles per liter Sat. Sol.		t°	moles per liter Sat. Sol.	
	Na ₂ SO ₃	AgBr		Na ₂ SO ₃	AgBr
1.6	0.5719	0.00230	Room	0.0090	0.0000461**
	.0998	.000500	Temp.	.0165	.0000845**
10.6	0.5947	.00326	Cont.	.0385	.000175**
	.1089	.000500		.0751	.000281**
20.0	0.1188	.000895		.140	.00062**
	.0978	.000799		.303	.00141**
20.15	0.4553	.00418		.569	.00304**
25	0.232	.0025*		.665	.00533**
Br	.406 ^a	.0023*	29.0	0.6412	.00598
	.448 ^a	.0023*		.5635	.00380
	.466	.0053*		.1182	.00129
	.474	.0055*		.1127	.00129
	.675	.0084*	39.9	0.6072	.00840
"Room	0.0006	.00000533**		.1165 ^a	.00160
Temp"	.0013	.0000117**	50.5	0.5967	.00910
	.0024	.0000209**		.1145	.00185
	.0047	.0000239**		.1029	.00216

^aThese solutions also contained 0.01 mole excess Br⁻.

At 25° 0.04 gms. AgBr dissolve in 100 gms. of a solution containing 9.09%(1:10) Na₂SO₃.

At 25° 0.08 gms. AgBr dissolve in 100 gms. of a solution containing 16.67%(1:5) Na₂SO₃.

[not in agreement with the above tables] (Valenta, 1894).

SOLUBILITY OF SILVER BROMIDE IN POTASSIUM THIOCYANATE SOLUTIONS AT 25° (Randall and Halford, 1930)

moles per liter		moles per liter	
KSCN	AgBr	KSCN	AgBr
0.2510	0.0011	0.7577	0.0285
.2702	.0012	.7762	.0307
.5205	.0095	1.0089	.0663
.5819	.0085		

At 25° 0.73 gms. AgBr dissolve in 100 gms. of a solution containing 9.09%(1:10) KSCN (Valenta, 1894)

SOLUBILITY OF SILVER BROMIDE IN SOLUTIONS OF VARIOUS SALTS
(Valenta, 1894; Schierholz, 1890;
Mees and Piper, 1912; Bedell, 1938; Dubois, 1949)

Salt	t°	Composition of Solvent	Solubility of AgBr	Ref.
NH ₄ SCN	Room(?)	1%	0.03 gms. per liter	M.&P.
	20	4.76%(1:20)	0.21 gms. per 100 gms. solvent	V.
	20	9.09%(1:10)	2.04 "	V.
	20	13.04%(3:20)	5.30 "	V.
Ca(SCN) ₂	25	9.09%(1:10)	0.53 "	V.
Ba(SCN) ₂	25	9.09%(1:10)	0.35 "	V. Br
Al(SCN) ₃	25	9.09%(1:10)	4.50 "	V.
KCN	25	4.76%(1:20)	6.55(6.85)* "	V. (*calc. by Cohn, 1895)
Na ₂ SO ₄	Room(?)	1%	0.055 "	M.&P.
(NH ₄) ₂ CO ₃	Room(?)	1%	0.004 "	M.&P.
Hg(C ₂ H ₃ O ₂) ₂	20	10%	0.122 "	S.
Na glycinate	30	0.25 M	0.000595 moles per liter	D.
		0.50 M	.00119 "	D.
		1.00 M	.00236 "	D.
KNO ₃ LiNO ₃ Ba(NO ₃) ₂ Mn(NO ₃) ₂	Room (20°)	Bedell added 0.001 M AgNO ₃ to solutions of the metal bromides until a precipitate was observed. The con- centration or excess metal nitrate ranged between 0.0004 - 0.0252 gme. per liter.		

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS
OF THIOCYANIME AND THIOUREA (THIOCARBAMIDE)
(Oalenta, 1894; Mees and Piper, 1912)

	t°	Composition of solvent	Solubility of AgBr	Ref.
Thiocyanime	25	0.99%(1:100)	0.08 gms. per 100 gms. solvent	V.
	25	4.76%(1:20)	0.35 "	V.
	25	9.09%(1:10)	0.72 "	V.
Thio- carbamide (Thiourea)	25	9.09%(1:10)	1.87 "	V.
	Room(?)	1%	1.49 gms. per liter	M.&P.

SOLUBILITY OF SILVER BROMIDE IN METHANOL, ETHANOL AND DIETHYLETHER

Solvent	t°	Mols. AgBr per liter	Reference
Methanol	20-23°	3.5 x 10 ⁻⁶	Neustadt, 1910
	25°	1.9 x 10 ⁻⁶	Buckley and Hartley, 1929
	25°	3.0 x 10 ⁻⁶	Koch, 1930
Ethanol	20-23°	2.5 x 10 ⁻⁶	Neustadt, 1910
	25°	3.7 x 10 ⁻⁹	Koch, 1930
Diethylether [containing 1M LiClO ₄]	23.5°	1.3 ± 0.3 x 10 ⁻⁹	Althin, Wahlin & Sillen, 1949

Ag ARGENTUM

SOLUBILITY OF SILVER BROMIDE IN SODIUM BROMIDE SOLUTIONS IN AQUEOUS METHANOL, ETHANOL AND ACETONE SOLUTIONS AT 20° (Kratohvil and Tezak, 1954)

NaBr was added to AgNO₃ solutions until the turbidity of AgBr just disappeared. The solution therefore also contained NaNO₃ equal to the amount of AgBr dissolved. The dielectric constant D of each solvent is listed. All concentrations are given in moles per liter, solvents in weight percent. For similar solubilities in pure waters, see page 14.

Br	NaBr						
	Methanol	Ethanol				Acetone	
	62% D = 50.4	30% 62.6	50% 50.4	70% 39.1	90% 29.0	48.5% 50.4	82% 29.0
AgBr							
0.006	-	-	-	-	-	-	0.2125
.004	-	-	-	-	-	0.95	.15
.002	-	-	-	-	-	-	.0775
.001	0.975	1.35	1.0125	0.775	-	.48	.03625
.0006	-	-	0.78	-	-	-	.021
.0004	.625	0.875	.615	.44	-	.27	.0135
.0002	-	-	.425	-	0.175	-	.0063
.0001	.27	.425	.27	.158	.0925	.095	.002875
.00006	-	-	.195	-	.0545	-	.0018
.00004	-	.25	.145	.0675	.036	.044	.00105
.00002	.0875	-	.0875	-	.01775	-	.000525
.00001	-	.105	.043	.0163	.00725	.0115	.00024
.000006	-	-	.0255	-	.0045	-	-
.000004	-	-	-	-	-	.004	-

SOLUBILITY OF SILVER BROMIDE IN LIQUID AMMONIA AND SULFUR DIOXIDE

t° Gms. AgBr per 100 gms. NH₃

0	2.40	(Linhard and Stephan, 1933, 1934)
25	5.92	(Hunt and Boncyk, 1933)

Gms. AgBr per 100 gms. SO₂

0°	0.003	(Jander and Wickert, 1936; Jander and Ruppold, 1937)
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Melting point data are given for:

- AgBr + AgCl (Monkemeyer, 1906)
- AgBr + AgI (Monkemeyer, 1906; Stasiw and Telton, 1949)
- AgBr + AgNO₃ (Lifshitz, 1955)
- AgBr + AgNO₃ + AgCl (Lifshitz, 1955)
- AgBr + AlBr₃ (Kendall, Crittenden, and Miller, 1923)
- AgBr + CdBr₂ (Zakharchenko, 1951)
- AgBr + KBr (Sandonnini, 1912; Zenczuzny, 1926)
- AgBr + NaBr (Sandonnini and Scarpa, 1913; Zenczuzny, 1926)
- AgBr + PbBr₂ (Matthes, 1911)
- AgBr + NaCl \rightleftharpoons AgCl + NaBr (Tabmasvyan and Pokomilo, 1953)
- AgBr + KI \rightleftharpoons AgI + KBr (Tabmasvyan and Pokomilo, 1953)

SILVER BROMIDE THIOSINAMINE $\text{AgBr} \cdot \text{NH}_2 \cdot \text{CS} \cdot \text{HNC}_3\text{H}_5$ SOLUBILITY OF SILVER BROMIDE - THIOSINAMINE
(ALLYL THIO CARBAMIDE) IN WATER
(Sheppard and Hudson, 1927)

The solutions were shaken at constant temperature for 48 hours and the amount of compound dissolved determined by conversion to silver sulfide.

t°	AgBr·HN ₂ ·CS·NHC ₃ H ₅ per liter sat. aq. solution	
	Gms.	G. Mols. x 10 ⁻⁴
15	0.0446	1.46
25	0.071	2.33
35	0.121	3.94
50	0.293	9.63

SILVER BROMATE AgBrO_3

BrO

SOLUBILITY OF SILVER BROMATE IN WATER

Reedy, 1921 determined the solubility from 25° to 90°, and his value at 25° (0.196 gms. AgBrO_3 per 100 gms. sat. soln.) agrees with that found by Noyes, 1890 (0.191), Hill, 1917 (0.195), Delton, Pomeroy and Weymouth, 1924 (0.190), Owen, 1933 (0.192), Newman, 1934 (0.192), Vosburgh and Cogswell, 1943 (0.195), Davies and Monk, 1951 (0.191), Ricci and Offenbach, 1951 (0.193), Lelchuk, 1955 (0.195). The earlier data of Longi, 1883 (25°) and of Whitby, 1910 (27°) are too low, probably because of the method of preparation of the salt (see system $\text{AgBrO}_3 - \text{NaBrO}_3 - \text{H}_2\text{O}$, p. 21). The data of Koizumi and Miyamoto, 1950 at 20°, 25° and 30° and of Ricci and Aleshnick, 1944 at 25° are higher than those listed below by +0.010.

t°	Gms. AgBrO_3 per 100 gms. sat. sol.	t°	Gms. AgBrO_3 per 100 gms. sat. sol.	t°	Gms. AgBrO_3 per 100 gms. sat. sol.
5	0.0905 (R&A)	40	0.316	65	0.648
20	.159 (B)	45	.371	70	.735
25	.193 + .002(Ave.)	50	.433(.430, R.&A.)	75	.832
30	.227	55	.497	80	.936
35	.269	60	.570	85	1.055
				90	1.325

A transition point near 98.5° is indicated.

R&A = Ricci and Aleshnick 1944

B = Bottger, 1903

Ave. = Average of results of ten investigators.

Ag ARGENTUM

SOLUBILITY OF SILVER BROMATE IN ACIDS
(Longi, 1883)

	Gms. AgBrO ₃ per	
	1000 cc soln.	1000 gms. soln.
Nitric acid sp. gr. 1.21 (35%) at 25°	3.81	3.12

SOLUBILITY OF SILVER BROMATE IN AQUEOUS ACETIC ACID AT 25°
(Hill, 1917)

BrO Normality of Aq. Acetic Acid	Gms. AgBrO ₃ per liter	Normality of Aq. Acetic Acid	Gms. AgBrO ₃ per Liter
0.0498	1.9429	0.4988	1.863
0.0997	1.9379	0.9975	1.8013
0.1995	1.9206	1.8721	1.6178

SOLUBILITY OF SILVER BROMATE IN AQUEOUS AMMONIA AT 25°
(Longi, 1883)

	Gms. AgBrO ₃ per	
	1000 cc. Sol.	1000 Gms. Sol.
Sp. Gr. 0.998 = 5%	35.10	35.54
Sp. Gr. 0.96 = 10%	443.6	462.5

SOLUBILITY OF SILVER BROMATE IN PYRIDINE SOLUTIONS AT 25°
(Vosburgh & Cogswell, 1943)

gms. Pyridine per 100 gms. H ₂ O	0	0.472	0.656	1.007	1.237
gms. AgBrO ₃ " " " "	1.950	2.311	2.433	2.709	2.910

SOLUBILITY OF SILVER BROMATE IN SALT SOLUTIONS IN SILVER NITRATE
(Noyes, 1890)

gms. AgNO ₃ per liter	0.0	1.445	5.882
gms. AgBrO ₃ per liter	1.911	1.203	0.510

SOLUBILITY OF SILVER BROMATE IN
POTASSIUM BROMATE SOLUTIONS AT 25°
(Lelchuk, Surnina & Barkatova, 1955;
Noyes, 1890 (*) (at 24.5°))

moles per liter		moles per liter		moles per liter	
KBrO ₃	AgBrO ₃	KBrO ₃	AgBrO ₃	KBrO ₃	AgBrO ₃
0	.00825	.003	.00529	.030	.00249
0	.0081*	.0085	.00519*	.0346	.00227*
0.001	.00732	.010	.00399	.100	.00106
				.300	.000703

Ricci and Offenbach, 1951 found no double salts or solid solution in the system AgBrO₃ - KBrO₃ - H₂O at 25°. A solution saturated with both solids contains 7.55% KBrO₃, density = 1.053. BrO

SOLUBILITY OF SILVER BROMATE IN POTASSIUM BROMATE SOLUTIONS
CONTAINING SODIUM NITRATE
(Lelchuk, Surnina and Barkanova, 1955)

NaNO ₃ M	- moles AgBrO ₃ per liter -		
	0.001 M KBrO ₃	0.01 M KBrO ₃	0.1 M KBrO ₃
0	0.00734	0.00399	0.00106
0.001	.00754	.00482	.00107
.003	.00790	.00492	.00113
.010	.00822	.00509	.00120
.030	.00885	.00549	.00124
.100	.00967	.00637	.00134
.300	.0112	.00755	.00152
1.000	.0135	.0112	.00269

EQUILIBRIUM IN THE SYSTEM SILVER BROMATE - SODIUM BROMATE - WATER
(Ricci and Aleshnick, 1944)

It was found that silver bromate and sodium bromate form two series of solid solutions. Silver bromate dissolves in sodium bromate up to about 3%, and sodium bromate dissolves in silver bromate up to 39.0%, and this limit corresponds to the composition of the double salt AgBrO₃·NaBrO₃. This compound is stable in contact with solutions of varying composition, but forms a continuous solid solution with silver bromate. These facts explain the erratic results of determinations of the solubility of silver bromate when it was prepared by precipitation from sodium bromate solutions.

Ag ARGENTUM

Results at 25°

	Gms. NaBrO ₃ per 100 gms. sat. sol.	Gms. AgBrO ₃ per 100 gms. sat. sol.	d. of sat. sol.	Gms. AgBrO ₃ in 100 gms. solid phase by extrapolation	Solid Phase
	28.26±.02	0.0	1.264±.002		NaBrO ₃
	28.24	...	1.261	0.43	Solid Solution I
	28.16	...	1.261	1.7	"
	28.08	...	1.260	2.6	"
	*27.97±.02	...	1.260±.001		S.S.I + AgBrO ₃ ·NaBrO ₃
BrO	27.78	...	1.257	61.23	AgBrO ₃ ·NaBrO ₃
	27.05	...	1.248	61.03	"
	25.36	...	1.232	61.11	"
	22.71	...	1.203	61.16	"
	Average of 10 determinations:			60.95	"
	21.28	...	1.185	62.13	Solid Solution II
	16.99	...	1.143	63.23	"
	13.04	...	1.108	66.60	"
	10.28	...	1.079	72.86	"
	8.39	...	1.062	78.3	"
	7.17	0.01	1.051	84.0	"
	3.92	.03	1.025	94.8	"
	0.0	.204	.9985	100	AgBrO ₃

*Average of 17 determinations.

Results at 50°

	Gms. NaBrO ₃ per 100 gms. sat. sol.	Gms. AgBrO ₃ per 100 gms. sat. sol.	d. of sat. sol.	Gms. AgBrO ₃ in 100 gms. solid phase by extrapolation	Solid Phase
	35.64	0.0	1.341	59.3	NaBrO ₃
	35.25	...	1.333	60.1	S.S.I + AgBrO ₃ ·NaBrO ₃
	35.21	...	1.335	60.1	"
	35.25	...	1.335	60.9	"
	35.05	...	1.334	61.09	AgBrO ₃ ·NaBrO ₃
	34.73	...	1.331	60.88	"
	34.57	...	-	61.19	"
	28.77	...	1.258	63.29	Solid Solution II
	23.32	...	1.196	65.42	"
	0.0	0.430	0.9934	100	AgBrO ₃

SOLUBILITY OF SILVER BROMATE IN AQUEOUS SALT SOLUTIONS AT 25°
 (Dalton, Bomerooy and Weymouth, 1924; Vosburgh and Cogswell, 1943 (*))

Constant rotation for at least 16 hours was employed and equilibrium was approached both from above and below.

Salt	Gm. equiv. salt per 1000 gms. H ₂ O	Density of sat. sol.	Millimols. AgBrO ₃ per 1000 gms. H ₂ O	
None(-H ₂ O)....	0.0	0.9990	8.062	
KClO ₄	0.025	1.0010	8.716	
"	0.5	1.0033	9.190	BrO
"	0.10	1.0074	9.706	
K ₂ SO ₄	0.025	1.0009	9.292	
"	0.05	1.0028	10.015	
"	0.10	1.0062	11.092	
Mg(NO ₃) ₂	0.025	1.0003	8.935	
"	0.05	1.0018	9.414	
"	0.10	1.0046	10.090	
MgSO ₄	0.02	-	8.92	
"	0.051	-	9.67	
"	0.10	-	10.30	
"	0.1988	-	11.38	
Ba(NO ₃) ₂	0.025	1.0018	9.088	
"	0.05	1.0046	9.655	
"	0.10	1.0098	10.373	
Na ₂ SO ₄	0.05	1.0025	9.965	
"	0.10	1.0059	10.973	
"	1.00	1.0622	18.619	
CdSO ₄	0.10	1.0017	10.405	
"	0.50	1.0492	13.349	
Ce(NO ₃) ₃	0.0125	1.0002	8.888	
"	0.025	1.0014	9.336	
KNO ₃	0.040	-	9.12	
"	0.0477	-	9.49*	
"	0.100	-	9.92	
"	0.1002	-	10.27*	
"	0.200	-	11.06	
"	0.394	-	12.66	
"	0.401	-	13.04*	

Ag ARGENTUM

moles AgBrO₃ per liter at 25°
added salts

moles added salt per liter	Lelchuk, Surnina, and Barkamova, 1955	Lelchuk, 1955		Tananaev, Lelchuk and Petrovitakaya (1949)			
	NaNO ₃	Zn(NO ₃) ₂	Cd(NO ₃) ₂	Mg(NO ₃) ₂	Ca(NO ₃) ₂	Sr(NO ₃) ₂	Ba(NO ₃) ₂
0	0.00825	0.00825	...	0.00826	...	...	...
0.001	.00822	.00843	0.00831	.00856	0.00791	0.00840	0.00824
.003	.00831	.00875	.00842	.00872	.00807	.00859	.00839
.010	.00850	.00912	.00875	.00928	.00915	.00896	.00894
.030	.00927	.0102	.00910	.00981	.00988	.0100	.00991
.100	.01008	.0116	.0104	.0111	.0111	.0122	.0122
.300	.01138	.0147	.0132	.0127	.0133	.0143	.0149
1.000	.0148	.0193	.0174	.0173	.0181	.0194	...

SOLUBILITY OF SILVER BROMATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE + SODIUM PICRATE AT 20° (Gilbert, 1929)

Molality of Salt Solution		Molality of dissolved AgBrO ₃
NaNO ₃	NaOC ₆ H ₂ (NO ₂) ₃	
0.00	0.10	0.00848
0.10	0.00	0.00840
0.05	0.05	0.00838

SOLUBILITY OF SILVER BROMATE IN AQUEOUS ORGANIC SOLVENTS AT 25° (Owen, 1933; Newman, 1934; Davies and Monk 1951, Monk 1951)

Values of Davies and Monk are in parenthesis. Their data in methanol, ethylene glycol, and glycerol agree with those of Owen (listed).

Wt.% organic compound in solvent	millimoles AgBrO ₃ per liter of saturated solution							
	Meth- anol	Eth- anol	n- pro- panol	iso- pro- panol	eth- ylene glycol	gly- cerol	ace- tone	diox- ane*
0	8.12	8.12	8.12	8.12	8.12	8.12	8.12	8.12
10.0	5.51	5.53	5.80	5.5	7.26	7.80	5.92	6.24
20.0	3.79	3.86	4.36	3.95	6.50	7.49	4.29	4.76
							(4.09)	
30.0	2.65	2.78	3.31	2.92	5.85	7.15	3.00	...
							(2.79)	
40.0	1.82	1.97 (1.90)	2.41	2.1	5.26	6.84	2.03	...
							(2.03)	
50.0	1.24	1.36 (1.27)	1.63	1.5	4.70	6.48	...	...
60.0	0.83	...	...	...	...	6.08	...	...
70.0	...	...	...	...	3.61	5.59	...	...
80.0	...	...	...	...	...	4.94	...	...

*Monk, 1951, also see below. For data in aqueous pyridine solutions see p. 20, in phenol solutions, see below.

Data of Koizumi and Miyamoto, 1954 for Dioxane solutions: (read from plots of the author's data)

Wt. % dioxane	millimoles AgBrO ₃ per liter		
	20°	25°	30°
0	7.28	8.59	10.02
10	5.80	6.85	7.90
20	4.42	5.20	5.95
30	3.30	4.00	4.57
40	2.45	2.97	3.51

SOLUBILITY OF SILVER BROMATE IN AQUEOUS SOLUTIONS OF
UNSATURATED ALCOHOLS AT 25°
(Keefer, Andrews, and Kepner, 1949)

BrO

The ionic strength of the alcohol solutions was adjusted to 0.10 by the addition of KNO₃ prior to the addition of AgBrO₃. All data are given in moles per liter.

alcohol	Ag+	alcohol	Ag+	alcohol	Ag+	alcohol	Ag+
Allyl Alcohol		Crotyl Alcohol		Ethylvinyl- carbinol		Methylvinyl- carbinol	
0.585	2.98	0.702	1.87	0.472	2.68	0.255	2.12
.293	2.20	.527	1.73	.236	2.04	.204	1.93
.146	1.69	.351	1.54	.0944	1.52	.102	1.53
.0732	1.38	.176	1.30	.0472	1.28	.051	1.28
		.0878	1.16			.025	1.14
Methylallyl Alcohol		Phenol		2-Methyl-2- buten-1-ol		Vinylacetic acid*	
0.470	2.42	0.488	1.28	0.100	1.21	0.467	2.90
.235	1.84	.224	1.14	.050	1.12	.234	2.15
.118	1.48	.112	1.17	.020	1.05	.117	1.67
.059	1.27	0.0	0.989			.0585	1.37
						0.0	1.01

* $\mu = 1.0$ by addition of HClO₄.

SILVER CARBIDE Ag₂C₂
(SILVER ACETYLIDE)

C

SOLUBILITY IN ACID SOLUTIONS
(Babko and Grebel'skaya, 1952)

The "hydrolytic solubility product" $L = [Ag^+]^2 [C_2H_2] [OH^-]^2$ in HClO₄, HNO₃, and H₂SO₄ solutions was determined:

[H ⁺] moles per liter	L
0.1	1.0×10^{-37}
1.0	8.7×10^{-37}

Ag ARGENTUM

SOLUBILITY OF SILVER ACETYLIDE IN SILVER NITRATE AND SILVER PERCHLORATE SOLUTIONS (Veetin and Ralf, 1949)

Moles AgNO ₃ per liter	Millimoles C ₂ H ₂ per 100 ml to cause ppt'n of Ag ₂ C ₂	Moles AgClO ₄ per liter	Millimoles C ₂ H ₂ per 100 ml to cause ppt'n of Ag ₂ C ₂
0.50	0.04	0.50	1.7
.75	.13	.75	4.6
1.00	.42	1.00	13.4

The solubility of Ag₂C₂ was determined in solutions containing 2 M ClO₄⁻ ion, made up of x moles AgClO₄ and 2 - x moles NaClO₄ per liter. The results were as follows at 25°:

Moles Ag ⁺ per liter	Millimols Ag ₂ C ₂ per liter	Moles Ag ⁺ per liter	Millimols Ag ₂ C ₂ per liter
0.476	3.33	0.600	8.70
.500	4.10	.640	11.00
.540	5.55	.698	15.2

CH SILVER METHIONATE Ag₂CH₂(SO₃)₂

SOLUBILITY IN WATER AT 25°

Solid phase
anhydrous: 45.0 gms. per 100 gms. H₂O (Valeri and Baumrucker, 1949)
45.05 " " " " " (Backer and Terpstra, 1929)

Solid phase
dihydrate: 62.5 " " " " " (" " " ")

SILVER ACETATE CH₃COO Ag

SOLUBILITY IN WATER

(Nernst, 1889; Arrhenius, 1893; Goldschmidt, 1898;
Nauman and Rucker, 1905; Raupenstrauch, 1885;
Wright and Thompson, 1884, 1885; Larson and Adell, 1931 (*).)

The value at 25° is the average of Jaques, 1909, 1910; Hill and Simmons, 1909; Armstrong and Eyre, 1913; Knox and Will, 1919; MacDougall, 1930; MacDougall and Rehner, 1934; MacDougall and Bartsch, 1936; MacDougall and Larson, 1937; MacDougall and Allen, 1942; MacDougall and Peterson, 1947; Davis, Ricci and Sauter, 1939.

t°	gms. AgC ₂ H ₃ O ₂ per liter	t°	gms. AgC ₂ H ₃ O ₂ per liter	t°	gms. AgC ₂ H ₃ O ₂ per liter
0	7.22	20	10.4	50	16.4
10	8.75	25	11.11 ± .03	60	18.9
15	9.4	30	12.1	70	21.8
18	10.03*	40	14.1	80	25.2

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°
(Hill and Simmons, 1909)

Normality of Aq. HNO ₃	Per cent HNO ₃ in Solvent	d ₂₅ of Sat. Sol.	Gms. AgC ₂ H ₃ O ₂ per liter Sat. Sol.
0	0	1.005	11.13
0.50	3.096	1.072	85.31
1.00	6.128	1.140	161.9
2.00	11.757	1.267	307.4
4.02	22.386	1.470	549.3
5.03	27.328	1.561	656
6.44	33.813	1.670	792.2

Results are given for the solubility of AgC₂H₃O₂ + AgNO₃ in Aq. CH
HNO₃ at 25°.

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°
(Knox and Will, 1919)

Saturation was secured by constant agitation in a thermostat.

Gm. equiv. CH ₃ COOH per liter	Gms. CH ₃ COOAg per liter	Gm. equiv. CH ₃ COOH per liter	Gms. CH ₃ COOAg per liter	Gm. equiv. CH ₃ COOH per liter	Gms. CH ₃ COOAg per liter
0.0	11.13	5.99	8.72	12.32	5.33
1.00	10.73	6.80	8.29	12.97	4.96
2.00	10.32	8.01	7.73	13.97	4.29
2.98	9.98	8.97	7.31	14.96	3.43
4.19	9.52	9.96	6.78	15.93	2.48
4.98	9.19	11.02	6.15	17.28	1.09

SOLUBILITY OF SILVER ACETATE IN THE PRESENCE OF SILVER NITRATE

The data of Nernst (1889), Jaques (1910), and MacDougall (1942) agree. Those of Arrhenius (1893) seem too low.

Gms. AgNO ₃ per liter	Gms. AgC ₂ H ₃ O ₂ per liter		25° (Jaques) gms. per liter		25° (MacDougall) gms. per 1000 gms. H ₂ O		Density Sat. Sol.
	(Nernst)	(Arrhenius)					
	16°	19.8°	AgNO ₃	AgC ₂ H ₃ O ₂	AgNO ₃	AgC ₂ H ₃ O ₂	
0	10.05	9.85	2.77	9.93	8.359	8.359	1.0119
5	8.2	7.9	2.55	9.00	11.999	7.603	1.0142
10	7.0	6.6	11.10	7.41	16.124	6.855	1.0175
15	6.4	5.5	22.21	5.81	17.99	6.662	1.0187
20	5.7	4.5			33.81	5.250	1.0304
30	4.4	-			34.13	5.233	1.0302
40	3.2	-			52.73	4.582	1.0452

Ag ARGENTUM

RESULTS IN ETHANOL-WATER SOLUTIONS AT 25° (MacDougall, 1942)

CH	10.17 wt.% Ethanol			20.03 wt.% Ethanol			30.01 wt.% Ethanol		
	Gms. per 1000		Den-	Gms. per 1000		Den-	Gms. per 1000		Den-
	gms. solvent			gms. solvent			gms. solvent		
	AgNO ₃	AgC ₂ H ₃ O ₂	sity	AgNO ₃	AgC ₂ H ₃ O ₂	sity	AgNO ₃	AgC ₂ H ₃ O ₂	sity
	0	8.279	0.9875	0	6.011	1.9716	0	4.382	0.9538
	1.721	7.623	.9891	1.748	5.345	.9718	1.690	3.754	.9550
	8.537	5.665	.9921	8.603	3.719	.9756	8.491	2.477	.9595
	17.87	4.404	.9985	16.82	2.888	.9822	17.02	1.966	.9658
	34.33	3.435	1.0110	34.81	2.362	.9957	33.54	1.653	.9776
	51.05	1.977	1.0242	50.49	2.235	1.0080	51.00	1.552	.9915

SOLUBILITY OF SILVER ACETATE IN SILVER PERCHLORATE SOLUTIONS AT 25° (MacDougall, 1942)

In water			In 10.17 wt. % Ethanol		
Gms. per 1000 gms. H ₂ O		Density Sat. Sol.	Gms. per 1000 gms. solvent		Density Sat. Sol.
AgClO ₄	AgC ₂ H ₃ O ₂		AgClO ₄	AgC ₂ H ₃ O ₂	
0	11.140	1.0048	0	8.279	0.9875
10.552	8.206	1.0136	2.422	7.445	.9892
21.32	6.522	1.0205	10.201	5.578	.9937
41.39	5.225	1.0352	19.942	4.362	1.0002
62.35	4.882	1.0507	38.98	3.323	1.0141
			58.91	2.861	1.0297

In 20.03 wt. % Ethanol			In 30.01 wt. % Ethanol		
Gms. per 1000 gms. solvent		Density Sat. Sol.	Gms. per 1000 gms. solvent		Density Sat. Sol.
AgClO ₄	AgC ₂ H ₃ O ₂		AgClO ₄	AgC ₂ H ₃ O ₂	
0	6.011	0.9716	0	4.382	0.9538
2.131	5.316	.9726	2.102	3.719	.9552
10.815	3.582	.9777	10.981	2.334	.9607
21.20	2.749	.9853	21.02	1.856	.9680
41.61	2.123	1.0005	41.49	1.539	.9827
63.45	1.875	1.0162	61.66	1.471	.9970

SOLUBILITY OF SILVER ACETATE IN SOLUTIONS OF OTHER ACETATES

(for data in acetic acid, see page 27).

IN SODIUM ACETATE SOLUTIONS

Gms. NaC ₂ H ₃ O ₂ per liter	gms. AgC ₂ H ₃ O ₂ per liter			(Jaques, 1910)		(MacDougall and Allen, 1942)		
	16° (Nernst, 1889; Neuman and Ruekar, 1905)					25° gas. per 1000 gms. H ₂ O		Den- sity Sat. Sol.
	18° (Larsen and Adell, 1931)	18.6° (Arrhe- nius, 1893)	gms. per liter		NaC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂		
			NaC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂				
0	10.05	10.03	9.9	0	11.08	0.0	11.140	1.0048
5	6.3	6.6	6.6	1.97	9.27	0.933	10.256	1.0044
10	4.6	4.72	4.9	19.7	4.21	4.056	8.144	1.0044
15	3.8	3.97	4.1	98.5	2.33	7.296	6.692	1.0050
20	3.3	3.53	3.5	19.7	2.07	17.294	4.545	1.0085
30		2.92	2.8			42.81	3.086	1.0196
40		2.58	2.4			58.95	2.784	1.0272
60		2.25				90.14	2.512	1.0406
80		2.05						

CH

IN SOLUTIONS OF AQUEOUS ETHANOL AT 25°
(MacDougall and Allen, 1945)

In 10.17 wt.% Ethanol			In 20.03 wt.% Ethanol			In 30.01 wt.% Ethanol		
gas. per 1000 gms. solvent		Density Sat. Sol.	gas. per 1000 gms. solvent		Density Sat. Sol.	gas. per 1000 gms. solvent		Density Sat. Sol.
$\text{NaC}_2\text{H}_3\text{O}_2$	$\text{AgC}_2\text{H}_3\text{O}_2$		$\text{NaC}_2\text{H}_3\text{O}_2$	$\text{AgC}_2\text{H}_3\text{O}_2$		$\text{NaC}_2\text{H}_3\text{O}_2$	$\text{AgC}_2\text{H}_3\text{O}_2$	
0.0	8.279	0.9875	0.0	6.011	0.9716	0.0	4.382	0.9538
.951	7.461	.9879	.835	5.325	.9707	.857	3.697	.9536
4.125	5.538	.9879	4.067	3.662	.9717	4.620	2.319	.9547
8.141	4.276	.9884	8.253	2.784	.9732	8.24	1.880	.9559
16.16	3.183	.9924	16.30	2.197	.9768	16.92	1.579	.9596
40.45	2.355	1.0040	41.13	1.683	.9888	41.09	1.519	.9708
54.42	2.222	1.0110	57.35	1.798	.9962	54.89	1.571	.9774
80.70	2.125	1.0234	82.20	1.838	1.0068	83.60	1.704	.9890

IN POTASSIUM ACETATE SOLUTIONS AT 25°

Jaques, 1910 gms. per liter		MacDougall and Allen, 1942 gms. per 1000 gms. H_2O		Density Sat. Sol.
$\text{KC}_2\text{H}_3\text{O}_2$	$\text{AgC}_2\text{H}_3\text{O}_2$	$\text{KC}_2\text{H}_3\text{O}_2$	$\text{AgC}_2\text{H}_3\text{O}_2$	
2.22	9.60	1.123	10.241	1.0076
22.2	4.43	4.864	8.126	1.0076
11.1	2.41	10.089	6.281	1.0083
22.2	2.18	19.285	4.667	1.0118
		47.38	3.213	1.0229
		66.25	2.874	1.0319
		98.24	2.629	1.0451

Ag ARGENTUM

IN SOLUTIONS OF AQUEOUS ETHANOL AT 25° (MacDougall and Allen, 1945)

In 10.17 wt.% Ethanol gms. per 1000 gms. solvent			In 20.03 wt.% Ethanol gms. per 1000 gms. solvent			In 30.01 wt.% Ethanol gms. per 1000 gms. solvent		
KC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂	Density Sat. Sol.	KC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂	Density Sat. Sol.	KC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂	Density Sat. Sol.
1.053	7.540	0.9878	1.033	5.340	0.9717	1.026	3.657	0.9523
4.914	4.587	.9882	4.973	3.684	.9724	5.012	2.367	.9538
9.863	4.215	.9889	10.08	2.774	.9734	10.25	1.854	.9558
19.66	3.193	.9938	20.60	2.153	.9787	19.86	1.577	.9606
49.77	2.369	1.0071	48.69	1.828	.9918	49.68	1.523	.9740
68.51	2.233	1.0157	68.24	1.808	1.0007	68.64	1.596	.9819
84.81	2.182	1.0231	98.53	1.861	1.0132	98.93	1.723	.9941

CN

IN { CALCIUM ACETATE SOLUTIONS STRONTIUM ACETATE SOLUTIONS } AT 25° (MacDougall and Allen, 1942)

In calcium acetate gms. per 1000 gms. H ₂ O			In strontium acetate gms. per 1000 gms. H ₂ O		
Ca(C ₂ H ₃ O ₂) ₂	AgC ₂ H ₃ O ₂	Density Sat. Sol.	Ca(C ₂ H ₃ O ₂) ₂	AgC ₂ H ₃ O ₂	Density Sat. Sol.
1.757	9.668	1.0091*	2.147	9.863	1.0067
9.166	6.565	1.0113	10.393	6.840	1.0100
16.497	5.171	1.0133	21.233	4.974	1.0157
32.54	3.929	1.0186	43.68	3.659	1.0289
76.44	3.115	1.0400	108.01	2.809	1.0643
102.00	3.018	1.0505	149.19	2.731	1.0876
164.18	3.090	1.0776	230.85	2.789	1.1298

IN { CADMIUM ACETATE SOLUTIONS LEAD ACETATE SOLUTIONS } AT 25° (Jaques, 1910)

In Cadmium Acetate gms. per liter		In Lead Acetate gms. per liter	
Cd(C ₂ H ₃ O ₂) ₂	AgC ₂ H ₃ O ₂	Pb(C ₂ H ₃ O ₂) ₂	AgC ₂ H ₃ O ₂
1.15	10.39	1.63	10.69
5.76	8.10	8.13	9.45
11.52	6.71	16.26	8.34
57.6	4.33	81.3	7.26
115.2	3.95	162.6	5.99

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF NITRATE

IN SODIUM NITRATE SOLUTIONS IN WATER

18° (Larsson and Adell, 1931)			25° (MacDougall and Rehner, Jr., 1934)				
Moles per liter Sat. Sol.		d ₂₅ of Sat. Solution	Moles per 1000 gms. H ₂ O		d ₂₅ of Sat. Solution	Moles per 1000 gms. H ₂ O	
NaNO ₃	AgCH ₃ COO		NaNO ₃	AgC ₂ H ₃ O ₂		NaNO ₃	AgC ₂ H ₃ O ₂
0.0	0.0601	1.0086	0.04776	0.07040	1.0629	1.0504	0.09266
0.2	0.0686	1.0108	0.09648	0.07287	1.0718	1.2398	0.09464
0.4	0.0734	1.0162	0.1914	0.07640	1.0857	1.5325	0.09766
0.6	0.0767	1.0216	0.2868	0.08032	1.1038	1.9108	0.09958
0.8	0.0790	1.0269	0.3840	0.08246	1.1246	2.3884	0.1027
1.0	0.0810	1.0310	0.4767	0.08414	1.1458	2.8723	0.1059
		1.0371	0.5743	0.08615	1.1846	3.9954	0.1106
		1.0470	0.7631	0.08910	1.2628	6.0191	0.113
		1.0578	0.9533	0.09177	1.3212	8.0098	0.1123
					1.3753	10.225	0.1109

CH

IN SODIUM NITRATE SOLUTIONS IN AQUEOUS DIOXANE AT 25°

10 wt.% Dioxane in solvent
(Davis, Ricci & Sauter, 1939)
moles per 1000 ml sol'n.

NaNO ₃	AgC ₂ H ₃ O ₂
0.0	0.05032
.005084	.05081
.009924	.05116
.04979	.05413
.09073	.05585
.09996	.05649
.1999	.05985
.4927	.06583
.9979	.07209
1.999	.07781
2.999	.08034
3.172	.08067
4.002	.08076

20 wt.% Dioxane in solvent
(Ricci and Leo, 1941)
moles per 1000 ml sol'n.

NaNO ₃	AgC ₂ H ₃ O ₂
0.0	0.03613
.004984	.03671
.04996	.03996
.1024	.04238
.1999	.04545
.2884	.94751
.4998	.05119
.9529	.05368

30 wt.% dioxane in solvent
(Ricci and Leo, 1941)
moles per 1000 ml sol'n.

NaNO ₃	AgC ₂ H ₃ O ₂
0.0	0.02426
.01000	.02483
.04994	.02756
.09992	.03033
.2000	.03303
.4998	.03786
1.000	.04317

50 wt.% dioxane in solvent
(Ricci and Leo, 1941)
moles per 1000 ml sol'n.

NaNO ₃	AgC ₂ H ₃ O ₂
0.0	0.008572
.005001	.009223
.04999	.01192
.09988	.01351
.2000	.01569
.4998	.02005
.9995	.02453

IN POTASSIUM NITRATE SOLUTIONS IN WATER AT 25°
(MacDougall, 1930)

	moles per 1000 gms. H ₂ O		Density Sat. Sol.	moles per 1000 gms. H ₂ O		Density Sat. Sol.
	KNO ₃	AgC ₂ H ₃ O ₂		KNO ₃	AgC ₂ H ₃ O ₂	
	0.0501	0.06685	1.0077	0.8021	0.08786	1.0537
	0.1006	0.07281	1.0115	1.0155	0.09019	1.0658
	0.2001	0.07559	1.0180	1.2431	0.09214	1.0784
	0.3018	0.07941	1.0241	1.5437	0.09453	1.0944
	0.4010	0.08171	1.0298	2.0371	1.09754	1.1186
CH	0.5013	0.08344	1.0366	2.5355	0.09997	1.1426
	0.6040	0.08498	1.0417	3.0139	0.10163	1.1653

IN POTASSIUM NITRATE SOLUTIONS IN AQUEOUS DIOXANE AT 25°
(Davis, Ricci & Sauter, 1939)

Solvent = 10 wt.% dioxane			
moles per liter sol'n.		moles per liter sol'n.	
KNO ₃	AgC ₂ H ₃ O ₂	KNO ₃	AgC ₂ H ₃ O ₂
0.0	0.05032	0.2001	0.05929
.009978	.05099	.4992	.06476
.04995	.05377	.9985	.06959
.1020	.05619		

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF NITRATES AT 25°
(MacDougall and Rehner, Jr., 1934)

d ₂₅ of Sat. Solution	In Aqueous Lithium Nitrate Moles per 1000 gms. H ₂ O		d ₂₅ of Sat. Solution	In Aqueous Calcium Nitrate Moles per 1000 gms. H ₂ O	
	LiNO ₃	AgCH ₃ COO		Ca(NO ₃) ₂	AgCH ₃ COO
1.0050	0.0	0.06666	1.0062	0.00499	0.06825
1.0067	0.04817	0.07033	1.0071	0.00993	0.06920
1.0097	0.0994	0.07280	1.0084	0.01996	0.07187
1.0143	0.1996	0.07799	1.0126	0.04980	0.07691
1.0185	0.2997	0.08198	1.0191	0.09970	0.08365
1.0226	0.4002	0.08490	1.0318	0.1996	0.09311
1.0269	0.5004	0.08765	1.0560	0.3985	0.1067
1.0314	0.6101	0.09033	1.0792	0.5985	0.1170
1.0395	0.8195	0.09491	1.1225	0.9962	0.1363
1.0461	0.9975	0.09819	1.1726	1.4916	0.1588
1.0561	1.2636	0.1031	1.2634	2.4958	0.2034
1.0649	1.4997	0.1072	1.3766	3.9871	0.2759
1.0925	2.2835	0.1195			
1.1002	2.5193	0.1229			
1.1172	3.0305	0.1315			
1.1444	4.0221	0.1479			
1.2050	6.0125	0.1851			
1.2560	8.0153	0.2274			
1.3007	10.055	0.2768			

In Aqueous Barium Nitrate Moles per 1000 gms. H ₂ O			In Aqueous Strontium Nitrate (Cont.) Moles per 1000 gms. H ₂ O		
d ₂₅ of Sat. Solution	Ba(NO ₃) ₂	AgCH ₃ COO	d ₂₅ of Sat. Solution	(Sr(NO ₃) ₂	AgCH ₃ COO
1.0050	0.0	0.06666	1.1046	0.6036	0.1081
1.0064	0.005012	0.06796	1.1645	1.0064	0.1218
1.0076	0.01001	0.06910	1.2338	1.5072	0.1354
1.0100	0.01998	0.07127	1.3575	2.5092	0.1588
1.0161	0.05025	0.07597	1.4605	3.4941	0.1632
1.0273	0.1002	0.08104			
1.0489	0.2009	0.08331			
1.0697	0.3014	0.09361			
1.0796	0.3500	0.09572			
1.0876	0.3902	0.09755			

In Aqueous Strontium Nitrate Moles per 1000 gms. H ₂ O			In Aqueous Lanthanum Nitrate Moles per 1000 gms. H ₂ O		
d ₂₅ of Sat. Solution	(Sr(NO ₃) ₂	AgCH ₃ COO	d ₂₅ of Sat. Solution	La(NO ₃) ₃	AgCH ₃ COO
			1.0060	0.001431	0.06809
			1.0073	0.004859	0.07109
			1.0085	0.008374	0.07407
			1.0122	0.01839	0.06231
			1.0228	0.05047	0.1034
1.0063	0.00497	0.06768	1.0389	0.1016	0.1304
1.0071	0.01001	0.06870	1.0715	0.2113	0.1746
1.0090	0.02002	0.07133	1.1210	0.3908	0.2315
1.0134	0.05038	0.07628	1.1613	0.5434	0.2771
1.0229	0.1008	0.08178	1.2558	0.9216	0.3856
1.0402	0.2009	0.08936	1.4571	1.8568	0.6704
1.0727	0.4022	0.1001	1.6277	2.8185	1.0487

Data for the solubility of silver acetate in approximately 10, 20 and 30 wt.% aqueous ethanol solutions containing varying concentrations of NaNO₃, KNO₃, LiNO₃, Ca(NO₃)₂, Sr(NO₃)₂, and Ba(NO₃)₂ at 25° are given by MacDougall and Bartsch, 1936.

Data for the solubility of silver acetate in approximately 10, 20 and 30 wt.% aqueous acetone solutions containing varying concentrations of NaNO₃, KNO₃, Ca(NO₃)₂ and Sr(NO₃)₂ at 25° are given by MacDougall and Larson, 1937.

SOLUBILITY OF SILVER ACETATE IN SOLUTIONS OF SODIUM AND POTASSIUM CHLORATES AND PERCHLORATES

IN SODIUM PERCHLORATE SOLUTIONS IN WATER AT 25° (MacDougall and Peterson, 1947)

gms. NaClO ₄ per 1000 gms. H ₂ O	gms. AgC ₂ H ₃ O ₂ per 1000 gms. H ₂ O
0.0	11.182
419.56	10.282

Ag ARGENTUM

IN SODIUM CHLORATE SOLUTIONS IN AQUEOUS DIOXANE AT 25° (Ricci and Leo, 1941)

CM	Solvent 20 wt.% dioxane moles per liter sol'n.		Solvent 30 wt.% dioxane moles per liter sol'n.		Solvent 50 wt.% dioxane moles per liter sol'n.	
	NaClO ₃	AgC ₂ H ₃ O ₂	NaClO ₃	AgC ₂ H ₃ O ₂	NaClO ₃	AgC ₂ H ₃ O ₂
	0.0	0.03631	0.0	0.02426	0.0	0.008572
	.01000	.03727	.009953	.02553	.009952	.009663
	.05002	.04055	.05002	.02878	.04592	.01223
	.09991	.04322	.09952	.03097	.1000	.01414
	.1999	.04711	.1999	.03450	.1998	.01703
	.4997	.05438	.5003	.04189	.4996	.02264
	1.050	.06268	.9980	.04932	.9980	.02736

IN POTASSIUM CHLORATE SOLUTIONS IN AQUEOUS DIOXANE AT 25° (Davis, Ricci & Sauter, 1939)

Solvent 10 wt. % dioxane moles per liter sol'n.		Solvent 20 wt.% dioxane moles per liter sol'n.	
KClO ₃	AgC ₂ H ₃ O ₂	KClO ₃	AgC ₂ H ₃ O ₂
0.004987	0.05077	0.0	0.03613
.01007	.05127	.009331	.03703
.04995	.05429	.05005	.04023
.05017	.05429	.09988	.04275
.09987	.05695	.1506	.04487
.2018	.06093	.2000	.04660
.3045	.06453	.2996	.04913
.4002	.06637		

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF ORGANIC SOLVENTS AT 25°

Aqueous Ethanol (MacDougall and Bartsch, 1936)			Aqueous Acetone (MacDougall and Larson, 1937)			Aqueous Dioxane (Davis, Ricci & Sauter, 1939)		
wt.% ethanol in solvent	moles AgC ₂ H ₃ O ₂ per liter sat. sol.	den- sity sat. sol.	wt.% acetone in solvent	moles AgC ₂ H ₃ O ₂ per liter sat. sol.	den- sity sat. sol.	wt.% dioxane in solvent	moles AgC ₂ H ₃ O ₂ per liter sat. sol.	
5.0	0.0577	0.9955	9.27	0.0516	0.9920	0	0.06663	
7.62	.0523	.9898	9.81	.0499	.9910	10	.05035	
9.0	.0506	.9882	10.35	.0481	.9900	20	.03638	
15.03	.0413	.9784	18.83	.0324	.9758	30	.02452	
19.96	.0300	.9696	19.48	.0323	.9748	40	.01517	
25.06	.0294	.9616	20.03	.0322	.9740	50	.008564	
29.82	.0251	.9530	20.50	.0319	.9724	60	.004227	
30.05	.0249	.9526	28.25	.0214	.9592	70	.001740	
40.27	.0180	.9323	29.23	.0213	.9584	80	.000611	
50.14	.0124	.9102	30.02	.0213	.9564	85	.000285	
						90	.000154	
						95	.000021	
						100	.0000000	

Data of Armstrong and Kyre, 1913:

Aqueous Solution of:	gms. organic Compound per 1000 Gms. H ₂ O	Gms. AgC ₂ H ₃ O ₂ per 1000 Gms. Sat. Sol.	Aqueous Solution of:	gms. organic Compound per 1000 Gms. H ₂ O	Gms. AgC ₂ H ₃ O ₂ per 1000 Gms. Sat. Sol.	
Water	0	11.08	Propyl			
Acetalde- hyde	11	10.13	Alcohol	15	9.88	
Paralde- hyde	11	8.92	"	60	8.03	
Paralde- hyde	33	9.16	Glycerol	9.21	8.66	
Isobutyl			Glycol	15.5	10.86	CH
Alcohol	66.4	7.55	"	62.1	8.44	

SOLUBILITY OF SILVER ACETATE IN GLACIAL ACETIC ACID

t°	gms. AgC ₂ H ₃ O ₂ per 100 gms. Sat. Soln.	
25	0.086	(Peterson and Dienes, 1951)
30	.078	(Birdwhistell and Griswold, 1955)
76	.094	(Kendall and Adler, 1921)
115	.204	(" " " , ")

EQUILIBRIUM IN THE SYSTEM SILVER ACETATE - SILVER
NITRATE - ACETIC ACID AT 30°
(Birdwhistell and Griswold, 1955)

moles per 1000 gms. HC ₂ H ₃ O ₂		Solid Phase	moles per 1000 gms. HC ₂ H ₃ O ₂		Solid Phase
AgC ₂ H ₃ O ₂	AgNO ₃		AgC ₂ H ₃ O ₂	AgNO ₃	
0.0	0.00617	AgNO ₃	0.0034	0.0051	AgNO ₃ + AgC ₂ H ₃ O ₂
.0005529	.00595	"			
.001073	.00583	"	.00297	.006790*	AgC ₂ H ₃ O ₂
.001110	.00582	"	.00317	.005939*	"
.002661	.00535	"	.00337	.005208*	"
.002757	.00536	"	.00383	.003421	"
.003871	.00497*	"	.00426	.001957	"
			.00461	.0007541	"
			.00470	0.0	"

*metastable

Ag ARGENTUM

SOLUBILITY OF SILVER ACETATE IN ACETIC ACID SOLUTIONS CONTAINING SODIUM ACETATE OR LITHIUM NITRATE AT 30° (Birdwhistell and Griswold, 1955)

with NaC ₂ H ₃ O ₂ present (solid phase AgC ₂ H ₃ O ₂) moles per 1000 gms. HC ₂ H ₃ O ₂		with LiNO ₃ present (solid phase AgC ₂ H ₃ O ₂) moles per 1000 gms. HC ₂ H ₃ O ₂	
NaC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂	LiNO ₃	AgC ₂ H ₃ O ₂
0.0	0.00470	0.000400	0.00499
.000929	.00472	.001002	.00526
.002791	.00479	.008727	.00692
.01606	.00506	.01110	.00720
.02062	.00512	.01757	.00793
.02638	.00518	.02178	.00837
.03669	.00530	.03384	.00936
.04440	.00540	.04141	.01003
.07165	.00571	.06030	.01118
		.1285	.01441

SOLUBILITY OF SILVER ACETATE IN GLACIAL ACETIC ACID CONTAINING POTASSIUM ACETATE AT 25° (Peterson and Dienes, 1951)

The data were read from the smooth curve drawn by the authors through their somewhat scattered results.

Sat'd. sol'n. mole %		Solid phase	sat'd. sol'n. mole %		Solid phase
KC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂		KC ₂ H ₃ O ₂	AgC ₂ H ₃ O ₂	
0.0	0.031	AgC ₂ H ₃ O ₂	5.5	0.077	AgC ₂ H ₃ O ₂ + Double salt
2.0	.042	"	6.0	.077	" + "
4.0	.062	"	10.0	.077	" + "

100 gms. liquid SO₂ dissolve 0.017 gm. AgCH₃COO at 0°. (Jander and Wickert, 1936; Jander and Ruppold, 1937.)

CH SILVER MONOCHLORO ACETATE ClCH₂COOAg

SOLUBILITY IN WATER

t°	Gms. ClCH ₂ COOAg per liter	density Sat. Sol.	
16.9°	12.97	....	(Arrhenius, 1893)
25°	15.18	1.0095	(Hill and Simmons, 1909)
25°	15.69	1.0097	(MacDougall and Rehner, Jr., 1934)

SOLUBILITY OF SILVER MONOCHLORO ACETATE IN NITRIC ACID AT 25°
(Hill and Simmons, 1909)

Normality of Aq. HNO ₃	Gms. HNO ₃ per 100 Gms. Solvent	d ₂₅ of Sat. Sol.	Gms. AgC ₂ H ₃ ClO ₂ per liter	
0	0	1.0095	15.18	
0.25	1.564	1.0426	50.33	
0.50	3.096	1.0791	91.83	
1	6.128	1.1473	167.3	
2	11.757	1.2716	310.8	
4	22.277	1.4749	549.1	
5	27.185	1.5673	659.2	CH

SOLUBILITY OF SILVER MONOCHLORO ACETATE AT 16.9° IN
AQUEOUS SOLUTIONS OF:
(Arrhenius, 1893)

Silver Nitrate		Sodium Chloro Acetate	
Gms. AgNO ₃ per liter	Gms. CH ₂ ClCOOAg per liter	Gms. CH ₂ ClCOONa per liter	Gms. CH ₂ ClCOOAg per liter
0.0	12.97	0.0	12.97
9.6	10.05	3.88	10.05
17.0	7.55	7.77	8.16
		15.53	6.02
		31.07	4.19
		58.26	3.26

SOLUBILITY OF SILVER MONOCHLORO ACETATE IN AQUEOUS SOLUTIONS
OF NITRATES AT 25°
(MacDougall and Rehner, Jr., 1934)

In Aqueous Lithium Nitrate			In Aqueous Sodium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O		d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	LiNO ₃	CH ₂ ClCOOAg		NaNO ₃	CH ₂ ClCOOAg
1.0123	0.05039	0.08199	1.0125	0.04979	0.08004
1.0191	0.2001	0.09026	1.0219	0.1994	0.08923
1.0277	0.4004	0.09772	1.0334	0.3990	0.09617
1.0440	0.8081	0.1081	1.0555	0.7975	0.1059
1.0696	1.5025	0.1186	1.0907	1.4930	0.1170
1.1210	2.9908	0.1436	1.1583	2.9847	0.1320
1.2079	6.0071	0.1648	1.3798	9.9368	0.1568

Ag ARGENTUM

In Aqueous Potassium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	LiNO ₃	CH ₂ ClCOOAg
1.0127	0.05005	0.08306
1.0229	0.1999	0.09112
1.0353	0.3971	0.09825
1.0598	0.7980	0.1087
1.0851	1.2464	0.1183
1.1244	1.9923	0.1316
1.1728	2.9960	0.1440

In Aqueous Calcium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	Ca(NO ₃) ₂	CH ₂ ClCOOAg
1.0102	0.00499	0.08118
1.0127	0.01996	0.08503
1.0363	0.1996	0.1063
1.0611	0.3985	0.1208
1.1066	0.7958	0.1412
1.1782	1.4916	0.1728
1.3786	3.9871	0.2550

In Aqueous Strontium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	Sr(NO ₃) ₂	CH ₂ ClCOOAg
1.0100	0.004978	0.08139
1.0133	0.01988	0.08466
1.0279	0.09998	0.09524
1.0452	0.1989	0.1044
1.0786	0.3992	0.1175
1.1103	0.6008	0.1274
1.1407	0.7993	0.1362
1.2394	1.4977	0.1606
1.4180	2.9985	0.1975

In Aqueous Lanthanum Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	La(NO ₃) ₃	CH ₂ ClCOOAg
1.0103	0.001431	0.8211
1.0129	0.008374	0.08680
1.0268	0.05047	0.1080
1.0752	0.2113	0.1569
1.1226	0.3908	0.2441
1.2098	0.7371	0.2441
1.3149	1.2013	0.3164
1.4465	1.8568	0.4237
1.6080	2.8185	0.5939

In Aqueous Barium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	Ba(NO ₃) ₂	CH ₂ ClCOOAg
1.0097	0.0	0.07832
1.0100	0.00493	0.07995
1.0114	0.00987	0.08180
1.0136	0.01990	0.08340
1.0207	0.05000	0.08878

In Aqueous Barium Nitrate		
d ₂₅ of Sat. Sol.	Moles per 1000 gms. H ₂ O	
	Ba(NO ₃) ₂	CH ₂ ClCOOAg
1.0319	0.09916	0.09493
1.0535	0.2001	0.1035
1.0739	0.2980	0.1099
1.0846	0.3501	0.1131
1.0922	0.3871	0.1151

SILVER TRIFLUOR ACETATE CF₃COOAg

Solvent	t°	Gms. CF ₃ COOAg per 100 gms. sat. sol.
H ₂ O	18	63
Ether	18	43
Benzene	13	9.6
	20	11.9
	45	29.2
	50	36
CF ₃ COOH	29.8	13.15

Swarts (1939)

(Harra and Cady, 1954)

CH SILVER Methyl Ethyl ACETATE AgCH₃CH₂CH(CH₃)COO

SILVER Diethyl ACETATE Ag[(C₂H₅)₂CHCOO]

SILVER Trimethyl ACETATE Ag(CH₃)₃CCOO

SOLUBILITY OF EACH IN WATER
(Sedlitzky, 1887; Keppish, 1888; Stiassny, 1891)

t°	Gms. per 100 Gms. H ₂ O			t°	Gms. per 100 Gms. H ₂ O		
	AgC ₅ H ₉ O ₂ (methyl ethyl)	AgC ₆ H ₁₁ O ₂ (diethyl)	AgC ₅ H ₉ O ₂ (tri- methyl)		AgC ₅ H ₉ O ₂ (methyl ethyl)	AgC ₆ H ₁₁ O ₂ (diethyl)	AgC ₅ H ₉ O ₂ (tri- methyl)
0	1.112	0.402	1.10	50	1.602	0.536	1.47
10	1.126	0.413	1.15	60	1.827	0.585	1.57
20	1.182	0.432	1.22	70	2.093	0.643	1.68
30	1.280	0.458	1.22	80	2.402	...	1.80

SILVER Oipropyl ACETATE AgC₈H₁₅O₂

CH

100 gms. H₂O dissolve 0.123 gm. AgC₈H₁₅O₂ at 11.7°, and 0.190 gm. at 72°. (Furth, 1888.)

SILVER Phenyl ACETATE AgC₆H₅CH₂COO

100 cc. sat. solution in water contain 0.352 gm. Ag·C₆H₅CH₂COO at 25°. (Larson, 1927.)

SILVER PROPIONATE C₂H₅COOAg

SOLUBILITY IN WATER

(Raupenstrauch, 1885; Arrhenius, 1893; Goldschmidt, 1898; Larson, 1927; Fuhner, 1924; Peterson, Jones, Schmitt and Knabeshuh, 1952; Knox and Will, 1919)

t°	Gms. C ₂ H ₅ O ₂ Ag per liter	t°	Gms. C ₂ H ₅ O ₂ Ag per liter
0	5.12	30	9.93 (9.70)
10	6.78	50	13.35 (13.53 F.)
18.2	8.36 (A.)	70	17.64
20	8.36 (8.48)	80	20.30
25	9.06 (9. L.) (8.86 PJSK)*		
	9.04 (K & W)		

*density = 1.002

SOLUBILITY OF SILVER PROPIONATE IN AQUEOUS SOLUTIONS
OF PROPIONIC ACID AT 25°
(Knox and Will, 1919)

Gm. equiv. C ₂ H ₅ COOH per liter	Gms. C ₂ H ₅ COOAg per liter	Gm. equiv. C ₂ H ₅ COOH per liter	Gms. C ₂ H ₅ COOAg per liter
0.00	9.04	6.98	5.78
1.00	8.58	8.56	4.96
2.00	8.01	11.40	3.16
2.97	7.60	13.03	3.17
4.95	6.78		

Ag ARGENTUM

SOLUBILITY OF SILVER PROPIONATE IN AQUEOUS SOLUTIONS OF: (Arrhenius, 1893)

Silver Nitrate at 19.7°				Sodium Propionate at 18.2°			
Moles per liter		Gms. per liter		Mols. per liter		Gms. per liter	
AgNO ₃	C ₃ H ₅ O ₂ Ag	AgNO ₃	C ₃ H ₅ O ₂ Ag	C ₃ H ₅ O ₂ Na	C ₃ H ₅ O ₂ Ag	C ₃ H ₅ O ₂ Na	C ₃ H ₅ O ₂ Ag
0	0.0471	0	8.519	0	0.0462	0	8.362
0.0133	0.0415	2.289	7.511	0.0167	0.0393	1.607	7.114
0.0267	0.0379	4.577	6.86	0.0333	0.0345	3.215	6.244
0.0533	0.0307	9.059	5.556	0.0667	0.0258	6.429	4.670
0.100	0.0222	16.997	4.019	0.1333	0.0191	12.859	3.456
				0.2667	0.0131	25.718	2.371
				0.5000	0.0101	48.77	1.828

SOLUBILITY OF SILVER PROPIONATE IN SODIUM NITRATE SOLUTIONS AT 25° (Peterson, Jones, Schmitt, and Knabeshuh, 1952) (Selected Data)

moles pre 1000 gms. H ₂ O		density Sat. Sol.	moles per 1000 gms. H ₂ O		density Sat. Sol.
NaNO ₃	AgC ₂ H ₃ COO		NaNO ₃	AgC ₂ H ₃ COO	
0.0	0.04932	1.002	0.3605	0.06098	1.023
.0322	.05134	1.004	.4366	.06126	1.027
.0756	.05333	1.007	.5481	.06236	1.034
.1204	.05466	1.009	.6783	.06378	1.040
.1750	.05648	1.012	.7608	.06522	1.044
.2165	.05731	1.015	.9065	.06582	1.052
.2740	.05880	1.018	1.051	.06720	1.056

CH SILVER ETHYL XANTHATE Ag₂S₂COC₂H₅

The solubility product in water at 18°, is 3.51×10^{-17} . (Determined potentiometrically in potassium ethyl xanthate solutions.) (Pillipenko, 1949.)

SILVER BUTYRATE C_3H_7COOAg

CH

SOLUBILITY IN WATER

(Raupenstrauch, 1885; Linnemann, 1871; Goldschmidt, 1898;

Arrhenius, 1893; Harkins, 1911; Fuhner, 1924;

Peterson, Jones, Schmitt and Knabeshuh, 1952; Tommila and Nyrkio, 1955)

t°	Gms. C_3H_7COOAg per 100 gms. H_2O	t°	Gms. C_3H_7COOAg per 100 gms. H_2O	t°	Gms. C_3H_7COOAg per 1000 gms. H_2O
0	0.363 R	18.8	0.445 A	50	0.742, R, F
10	.419 R	20	.484 R	50	.687 TN
14	.495 L	25	.472 PJSK	60	.848 R
15	.413 TN	25	.496 TN	70	.964 R
16	.413 G	30	.561 R	81	1.14 R
17.8	.432 A	40	.647 R		
18.2	.437 H	40	.610 TN		

SOLUBILITY OF SILVER BUTYRATE IN AQ. SOLUTIONS OF SILVER ACETATE,
SILVER NITRATE AND OF SODIUM BUTYRATE
(Arrhenius, 1893)

In Silver Acetate at 17.8°				In Silver Nitrate at 18.8°			
G. Mols. per liter		Grams per liter		G. Mols. per liter		Grams per liter	
CH_3COOAg	C_3H_7COOAg	CH_3COOAg	C_3H_7COOAg	$AgNO_3$	C_3H_7COOAg	$AgNO_3$	C_3H_7COOAg
0.0	0.0221	0.0	4.32	0.0	0.0228	0.0	4.445
0.0270	0.0139	4.51	2.71	0.0667	0.0078	11.33	1.521
0.0506	0.0103	8.45	2.01	0.100	0.0062	17.00	1.209

In Sodium Butyrate at 18.2°							
G. Mols. per liter		Grams per liter		G. Mols. per liter		Grams per liter	
C_3H_7COONa	C_3H_7COOAg	C_3H_7COONa	C_3H_7COOAg	C_3H_7COONa	C_3H_7COOAg	C_3H_7COONa	C_3H_7COOAg
0.0	0.0224	0.0	4.363	0.0658	0.0091	7.24	1.774
0.0066	0.0199	0.73	3.881	0.1315	0.0060	14.47	1.170
0.0164	0.0169	1.81	3.296	0.263	0.0040	28.96	0.780
0.0329	0.0131	3.62	2.555	0.493	0.0027	54.28	0.526

Ag ARGENTUM

SOLUBILITY OF SILVER BUTYRATE IN SODIUM NITRATE SOLUTIONS AT 25° (Peterson, Jones, Schmitt and Knabeshuh, 1952) [Selected Data]

moles per 1000 gms. H ₂ O		Density Sat. Sol.	moles per 1000 gms. H ₂ O		Density Sat. Sol.
NaNO ₃	AgC ₃ H ₇ COO		NaNO ₃	AgC ₃ H ₇ COO	
0.0	0.0242	1.000	0.3361	0.03061	1.020
0.0160	.02495	1.000	.4132	.03131	1.023
.0280	.02569	1.001	.5313	.03180	1.029
.0663	.02670	1.003	.6989	.03245	1.040
.0822	.02721	1.005	.8229	.03291	1.040
.1580	.02833	1.010	1.1349	.03436	1.066
.2164	.02951	1.012			

SOLUBILITY OF SILVER BUTYRATE IN AQUEOUS ETHANOL SOLUTIONS (Tommila and Nyrkio, 1955)

Solvent wt. % C ₂ H ₅ OH	Gms. C ₃ H ₇ COOAg per 100 gms. solvent		Solvent wt. % C ₂ H ₅ OH	Gms. C ₃ H ₇ COOAg per 100 gms. solvent	
	25°	40°		25°	40°
0	0.496	0.610	12.9	0.353	0.457
4.0	.437	.555	17.5	.298	.423
8.5	.382	...	36.0	.204	...
10.0	.369	.480			

CH SILVER ISO-BUTYRATE (CH₃)₂CHCOOAg

SOLUBILITY IN WATER (Raupenstrauch, 1885)

t°	gms. (CH ₃) ₂ CHCOOAg per 100 gms. H ₂ O	t°	gms. (CH ₃) ₂ CHCOOAg per 100 gms. H ₂ O
0	0.796	30	1.060 (1.102)
10	0.874	40	1.176
20	0.961 (.999)	50	1.313
25	1.044	70	1.670
		81	1.898

SILVER FUMARATE C₄H₂O₄Ag₂

100 gms. H₂O dissolve 0.013 gm. silver fumarate at 30°. (Weiss and Downs, 1923)

SILVER MALEATE C₄H₂O₄Ag₂

100 gms. H₂O dissolve 0.12 gm. silver maleate at 30°. (Weiss and Downs, 1923.)

SILVER MALATE $C_4H_4O_5Ag_2$

CH

100 gms. H_2O dissolve 0.0119 gms. at 18° and 0.1216 gm. at 25° .
(Partheil and Hübner, 1903.)

SILVER TARTRATE $C_4H_4O_6Ag_2$

SOLUBILITY IN WATER

t°	gms. $Ag_2C_4H_4O_6$ per		
	1000 gms. H_2O	liter of solution	
18°	.....	1.56	(Kolthoff, 1926)
	2.012	....	(Parthiel and Hübner, 1903)
25°	2.013	....	( " " " " )

SOLUBILITY IN BORIC ACID SOLUTIONS AT 18°
(Kolthoff, 1926)

Solvent	Gms. $Ag_2C_4H_4O_6$ per liter sat. sol.
0.1 M H_3BO_3	2.69
0.5 M H_3BO_3	6.87

SILVER SUCCINATE $C_4H_4O_4Ag_2$

100 gms. H_2O dissolve 0.0176 gm. at 18° , and 0.0199 gm. at 25° .
(Partheil and Hübner, 1903.)

SILVER β methyl ADIPATE (Neutral Salt) $AgOOCCH_2CH_2CH(CH_3)CH_2COOAg$

100 cc. sat. solution of silver β methyl adipate in water contain
0.12 gm. of the compound at 20° . (Meurisse.)

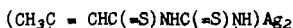
Ag ARGENTUM

SILVER PYRIMIDINE DERIVATIVES $\text{Ag}(\text{C}_4\text{H}_4\text{N}_2)^+$

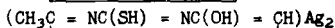
SOLUBILITY PRODUCTS IN NEUTRAL AND ALKALINE SOLUTIONS
(Kikuchi and Sakaguchi, 1950, 1951)

	Ksp		
	Neutral 25°	Alkaline	
		25°	50°
Silver - 2-thio-6-methyluracil	$(1 \times 10^{-12})^1$	$(1 \times 10^{-16})^2$	$(5 \times 10^{-15})^2$ $(6 \times 10^{-16})^1$
" 1-allyl-2-thio-6-methyluracil		1×10^{-15}	6×10^{-14}
" 2,4-dithio-6-methyluracil	1×10^{-14}	1×10^{-19}	4×10^{-18}
" 2-thio-6-amino-uracil		5×10^{-16}	1×10^{-14}
" 2,6-diamino-4(3H)pyrimidone			3×10^{-9}
" Ethyl 3,4-dihydro-2-(methylthio)-4-oxo-5 pyrimidine carboxalate		1×10^{-17}	1×10^{-16}

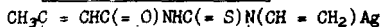
Ksp Data at
"room temp"
(neutral
solution (?))



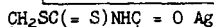
$0.1 - 2.0 \times 10^{-35}$



1×10^{-30}



1×10^{-15}



3×10^{-27}



2×10^{-31}

^{1,2}refer to different samples of the compound

CH SILVER LEVULINATE (Acetal PROPIONATE) $\text{AgCH}_3\text{COCH}_2\text{CH}_2\text{COO}$

SOLUBILITY IN WATER
(Furcht and Lieben, 1909)

t°	Gms. per 100 Gms. Sat. Solution	
8	0.5363 (white salt)	0.5195 (yellow salt)
9	0.5166 "	0.5372 "
14-15	0.6078 "	0.6448 "
99.6	3.49 "	3.70 "

SILVER VALERATES $\text{AgC}_5\text{H}_9\text{O}_2$

CH

Normal Valerate, $\text{CH}_3(\text{CH}_2)_3\cdot\text{COOAg}$. Iso Valerate, $\text{CH}_3\cdot\text{CH}(\text{CH}_3)_2\text{CH}_2\text{COOAg}$.

SOLUBILITY OF EACH SEPARATELY IN WATER
(Fürth, 1888; Sedlitzky, 1887; Arrhenius, 1893; Markwald, 1899;
Taverne, 1900; Fuhner, 1924)

t°	gms. per 100 gms. H ₂ O		t°	gms. per 100 gms. H ₂ O	
	Normal V.	ISO-V.		Normal V.	ISO-V.
0	0.229	0.177	30	0.349	0.283
10	.259	.211	40	.408	.321
15	.71 ?(T.)	.....	50	.474	.360
16.5	.196 (A.)	.....		.476 (F.)	.....
17.8	.196 (A.)	.....	60	.552	.401
18.6	.199 (A.)	.....	70	.636	.443
20	.300	.246	80	.....	.486
	.73 ?(M.)	.....		

SOLUBILITY OF SILVER VALERATE IN AQUEOUS SOLUTIONS OF SILVER
ACETATE, SILVER NITRATE AND OF SODIUM VALERATE
(Arrhenius, 1893)

In Silver Acetate at 17.8°

Mols. per liter		Gms. per liter	
$\text{C}_2\text{H}_3\text{O}_2\text{Ag}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$	$\text{C}_2\text{H}_3\text{O}_2\text{Ag}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$
0	0.0094	0	1.96
0.0067	0.0070	1.13	1.46
0.0135	0.0057	2.27	1.19
0.0270	0.0037	4.54	0.77
0.0505	0.00265	8.48	0.55

In Silver Nitrate at 16.5°

Mols. per liter		Gms. per liter	
AgNO_3	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$	AgNO_3	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$
0	0.0094	0	1.96
0.0067	0.0068	1.14	1.42
0.0133	0.0051	2.29	1.07
0.0267	0.0031	4.58	0.65
0.1000	0.0012	17.	0.25

In Sodium Valerate at 18.6°

Mols. per liter		Gms. per liter	
$\text{C}_5\text{H}_9\text{O}_2\text{Na}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$	$\text{C}_5\text{H}_9\text{O}_2\text{Na}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag}$
0	0.0095	0	1.986
0.0175	0.0047	2.17	0.982
0.0349	0.0030	4.32	0.627
0.0698	0.0018	8.65	0.376
0.1395	0.0015	17.31	0.313

Ag ARGENTUM

CH SILVER CAPROATES $\text{Ag}(\text{C}_6\text{H}_{11}\text{O}_2)$. (Silver hexanoates)

SOLUBILITY OF EACH SEPARATELY IN WATER
(Keppish, 1888; Stiassny, 1891; Kulisch, 1893; König, 1894;
Altschul, 1896; Fuhner, 1924)

Results in terms of gms. salt per 100 gms. H_2O .

t°	Normal Caproate $\text{CH}_3(\text{CH}_2)_4\text{COOAg}$		2 Methyl Pentan 4 Acid $\text{CH}_3\cdot\text{CH}\cdot\text{CH}_3\cdot$ $(\text{CH}_2)_2\text{COOAg}$	Methyl 3 Pentan Acid 4 $\text{CH}_3\cdot\text{CH}_2\cdot\text{CH}$ $\text{CH}_3\text{CH}_2\text{COOAg}$	4 Methyl Pentan 4 Acid $\text{CH}_3(\text{CH}_2)_2\text{CH}$ $(\text{CH}_3)_2\text{COOAg}$
	(Keppish)		(König)	(Kulisch)	(Stiassny)
0	0.076(A.)	0.078	0.168	0.880	0.510
10	0.085(A.)	0.089	0.162	0.858	0.528
20	0.100(A.)	0.107	0.163	0.849	0.550
30	0.123(A.)	0.131	0.170	0.854	0.574
40	0.154(A.)	0.161	0.183	0.871	0.602
50	0.193(A.&F.)	0.198	0.203	0.902	0.632
60	0.240(A.)	0.243	0.229	0.946	0.666
70	0.295(A.)	0.288	0.263	1.003	0.702
80	0.354(A.)	...	0.300	1.073	0.742
90	...	...	0.347	1.157	...

SILVER CITRATE $\text{C}_6\text{H}_5\text{O}_7\text{Ag}_3$

100 gms. H_2O dissolve 0.0277 gm. $\text{C}_6\text{H}_5\text{O}_7\text{Ag}_3$ at 18°, and 0.0284 gm. at 25°. (Partheil and Hübner, 1903.)

SILVER CUPFERRATE (Nitro o-PHENYL HYDROXYLAMINE) $\text{Ag}[\text{C}_6\text{H}_5\cdot\text{N}(\text{NO})\text{O}]$

at 18°, 0.150 gms. $\text{AgC}_6\text{H}_5\text{N}(\text{NO})\text{O}$ dissolve in one liter of water. (Determined potentiometrically and conductimetrically.) (Pinkus and Martin, 1927.)

SILVER BENZOATE $\text{Ag}[\text{C}_6\text{H}_5\text{COO}]$

SOLUBILITY OF SILVER BENZOATE IN WATER

t°	Gm. Mol. $\text{Ag}[\text{C}_6\text{H}_5\text{COO}]$ per liter	Gms. $\text{Ag}[\text{C}_6\text{H}_5\text{COO}]$ per liter	Authority
14.5		1.763	(Holleman, 1893)
18.0	0.01038	2.375	(Larson and Adel, 1931)
20.0		2.17	(Ephraim and Pfister, 1925)
25.0	0.01144	2.61	(Noyes and Schwartz, 1898)
25.0	0.01162	2.66	(Kolthoff and Bosch, 1932)

SOLUBILITY OF SILVER BENZOATE AT 25° IN AQUEOUS SOLUTIONS OF:
(Noyes and Schwartz, 1898)

Nitric Acid				Chloracetic Acid			
Gms. Mols. per liter		Gms. per liter		Gms. Mols. per liter		Gms. per liter	
HNO ₃	C ₆ H ₅ COOAg	HNO ₃	C ₆ H ₅ COOAg	CH ₂ ClCOOH	C ₆ H ₅ COOAg	CH ₂ ClCOOH	C ₆ H ₅ COOAg
0	0.01144	0	2.607	0	0.01144	0	2.607
0.004435	0.01395	0.280	3.195	0.00394	0.01385	0.371	3.172
0.00887	0.01698	0.559	3.889	0.00787	0.01612	0.744	3.691
0.00892	0.01715	0.562	3.926	0.01574	0.02093	1.487	4.792
0.01774	0.02324	1.118	5.321				
0.02674	0.03071	1.686	7.031				

SOLUBILITY OF SILVER BENZOATE IN AQUEOUS SOLUTIONS OF SALTS
(Larson and Adell, 1931 (18°); Kolthoff and Bosch, 1932 (25°))

Aq. Solution of:	t°	Gm. Mols. per liter		Aq. Solution of:	t°	Gm. Mols. per liter	
		Salt	Ag C ₆ H ₅ COO			Salt	Ag C ₆ H ₅ COO
AgNO ₃	25°	0.01	0.00786	NaNO ₃	18°	0.0	0.01038
		0.02	0.00576			0.10	0.01215
		0.03	0.00447			0.30	0.01351
		0.04	0.00392			0.50	0.01422
		0.05	0.00328			1.00	0.01523
NaC ₆ H ₅ COO	25°	0.10	0.00248		18°	2.00	0.01624
		0.01	0.00816			3.00	0.01610
		0.02	0.00585	LiNO ₃	25°	0.50	0.01628
		0.03	0.00477			0.50	0.01628
		0.04	0.00396			0.0	0.01038
KNO ₃	18°	0.05	0.00347			0.06	0.01214
		0.10	0.00240			0.08	0.01235
		0.05	0.01172			0.125	0.01306
		0.10	0.01221			0.160	0.01323
		0.30	0.01363			0.20	0.01366
		0.50	0.01424			0.50	0.01697
		0.80	0.01476	Mg(NO ₃) ₂	25°	0.498	0.01759
		1.00	0.01507			0.668	0.01784
		2.00	0.01593			0.253	0.01633
		3.00	0.01576			0.507	0.01834
		25°	0.05			1.013	0.02079
	25°	0.09	0.01369	NaC ₂ H ₃ O ₂	18°	0.0	0.01038
		0.10	0.01366			0.0099	0.01055
		0.25	0.01483			0.0496	0.01196
		0.50	0.01590			0.0992	0.01303
						0.2974	0.01608

SOLUBILITY IN ALCOHOL

One liter of cold alcohol dissolves 0.169 gm. C₆H₅COOAg; one liter of boiling alcohol dissolves 0.465 gm. (Liebermann, 1902.)

Ag ARGENTUM

CH SILVER Chloro, Nitro, etc. BENZOATES

SOLUBILITY OF EACH SEPARATELY IN WATER AT 20°
(Ephraim and Pfister, 1925)

Compound	Formula	Gms. anhydrous compound per 100 cc. sat. sol.
Silver 4-Chloro Benzoate...	$C_6H_4ClCOOAg$	0.108
" 4-Methoxy " ...	$C_6H_4 \cdot OCH_3 \cdot COOAg$	0.0518
" 4-Nitro " ...	$C_6H_4 \cdot NO_2 \cdot COOAg$	0.170
" 4-Oxy " ...	$C_6H_4 \cdot OH \cdot COOAg \cdot 3H_2O$	0.272

SILVER SALICYLATE $C_6H_4(OH)COOAg$ 1,2

SOLUBILITY IN WATER

t° gms. $C_6H_4(OH)COOAg$ per liter

18	0.813	(Kolthoff, 1926)
23	0.95	(Holleman, 1893)

SILVER HEPTOATE (Olanthylate) $AgC_7H_{13}O_2$

SOLUBILITY IN WATER (Landau, 1893; Altschul, 1896)

t°	Gms. $AgC_7H_{13}O_2$ per 100 Gms. H_2O		t°	Gms. $AgC_7H_{13}O_3$ per 100 Gms. H_2O	
	(Landau)	(Altschul)		(Landau)	(Altschul)
0	0.0635	0.0436	50	0.1652	0.0858
10	0.0817	0.0494	60	0.1906	0.1036
20	0.1007	0.0555	70	0.2185	0.1351
30	0.1206	0.0617	80	0.2495	0.1688
40	0.1420	0.0714			

SILVER CINNAMATE $C_6H_5 \cdot CH:CHCOOAg$

100 gms. sat. solution of silver cinnamate in water contain 0.012 gms. $C_6H_5CH:CHCOOAg$ at 20°. (Ephraim and Pfister, 1925.)

SILVER a-NAPHTHOATE $Ag[C_{10}H_7COO]$

One liter H_2O dissolves 1.67 gm. $Ag[C_{10}H_7COO]$ at 25°. (Larsson, 1927.)

SILVER SULFONATES

CH

SOLUBILITY OF EACH SEPARATELY IN WATER
(Ephraim and Pfister, 1925a)

Compound	Formula	t°	Gms. anhydrous compound per 100 cc. sat. sol.
Silver anthracene-1-sulfonate.....	AgC ₁₄ H ₉ SO ₃	20	0.059
" " -2- "	"	20	0.0318
" naphthalene-2- "	AgC ₁₀ H ₇ SO ₃	16.5	1.716
" " -5-chlor-1-sulfonate.....	AgC ₁₀ H ₆ SO ₃ Cl	20	0.551
" phenanthrene-2-sulfonate.....	AgC ₁₄ H ₉ SO ₃	20	0.099
" " -3- "	"	20	0.20
" " -10- "	"	20	0.52

SILVER HELIANTHATE C₁₄H₁₄N₃SO₃Ag·2H₂O

1000 cc. H₂O dissolve 0.292 gm. C₁₄H₁₄N₃SO₃Ag·2H₂O at 20-25°.
(Stark and Dehn, 1918.)

SILVER p-DIETHYLAMINO BENZILIDENE RHODANATE Ag(C₃HOS₂) = CHC₆H₄N(C₂H₅)₂

At 20°, at an ionic strength of 0.05, in 20% ethanol, the solubility product is 8×10^{-19} . (Sandell and Neimayer, 1951.)

SILVER PALMITATE CH₃(CH₂)₁₄COOAg

1000 cc. sat. solution of silver palmitate in water contain 0.00123 gm. C₁₅H₃₁COOAg at 20°. (Whitby, 1926.)

SILVER STEARATE CH₃(CH₂)₁₆COOAg [See also p. 50]

1000 cc. sat. solution of silver stearate in water contain 0.00065 gm. C₁₇H₃₃COOAg at 20°. (Whitby, 1926.)

Ag ARGENTUM

CH SILVER LAURATE, MYRISTATE, PALMITATE and STEARATE

SOLUBILITY OF EACH, DETERMINED SEPARATELY, IN WATER AND OTHER SOLVENTS AT SEVERAL TEMPERATURES
(Jacobson and Holmes, 1916)

Solvent	t°	Gms. each Salt per 100 Gms. Solvent			
		Laurate	Myristate	Palmitate	Stearate
Water	35	...	0.007	0.004	0.004
"	50	...	0.007	0.006	0.004
Abs. Ethyl Alcohol	25	0.009	0.008	0.007	0.007
" " "	50	0.009	0.008	0.007	0.007
Methyl Alcohol	15	0.074	0.063	0.060	0.051
" "	25	0.072	0.067	0.059	0.052
" "	35	0.078	0.071	0.062	0.055
" "	50	0.083	0.073	0.066	0.060
Ether	15	0.010	0.009	0.009	0.007

CN SILVER CYANIDE AgCN

SOLUBILITY OF SILVER CYANIDE IN WATER

t°	Mols. AgCN per liter	Gms. AgCN per liter	Method	Authority
17.5	3.17×10^{-7}	0.000042	Conductivity	(Abegg and Cox, 1903)
18.0	2.10×10^{-7}	0.000028	Potentiometric	(Masaki, 1930)
20.0	1.64×10^{-6}	0.00022	Conductivity	(Bottger, 1903)
25.0	5.24×10^{-4}	0.0702	Potentiometric	(Sato and Sato, 1954)

Ricci (1947) has made a critical evaluation of the solubility product of Silver Cyanide and the effect of adding various electrolytes to the solution.

SOLUBILITY OF SILVER CYANIDE IN AQUEOUS SOLUTIONS OF HYDROCYANIC ACID AT 25° (Randall and Halford, 1930)

moles per 1000 gms. H ₂ O		moles per 1000 gms. H ₂ O	
HCN	AgCN	HCN	AgCN
0.0296	0.000983	0.2275	0.00424
0.1016	0.00204	0.2325	0.00315
0.1596	0.00245	0.3000	0.00375
0.1780	0.00366	0.3625	0.00331
0.1825	0.00246	0.4230	0.00400
0.2124	0.00292	0.4260	0.00511
0.2245	0.00272	0.4465	0.00427

SOLUBILITY OF SILVER CYANIDE IN AQUEOUS AMMONIA SOLUTIONS
(Longi, 1883)

100 gms. aq. ammonia of 0.998 Sp. Gr. = 5%, dissolve 0.232 gm. AgCN at 12°.

100 gms. aq. ammonia of 0.96 Sp. Gr. = 10%, dissolve 0.542 gm. AgCN at 18°.

SOLUBILITY OF SILVER CYANIDE IN SILVER NITRATE SOLUTION

One liter aq. 3 n AgNO₃ dissolves 0.0091 gm. mol. = 1.216 gm. AgCN at 25°. (Hellwig, 1900.)

CN

SOLUBILITY OF SILVER CYANIDE IN AQUEOUS SOLUTIONS
OF POTASSIUM CYANIDE AT 25° AND VICE VERSA
(Bassett and Corbet, 1924)

Gms. per 100 gms. sat. sol.		Solid phase	Gms. per 100 gms. sat. sol.		Solid Phase
KCN	AgCN		KCN	AgCN	
41.7	0.00	KCN	20.14	21.66	KAg(CN) ₂
40.77	6.52	"	8.56	16.11	"
39.91	8.14	"	8.05	15.76	KAg ₂ (CN) ₃ ·H ₂ O
40.24	19.93	"	8.93	17.73	"
40.44	13.71	K ₃ Ag(CN) ₄ ·H ₂ O	6.75	13.53	AgCN
37.76	18.92	"	2.36	4.42	"
35.19	25.18	"	1.64	3.27	"
28.43	26.37	KAg(CN) ₂	1.26	2.31	"
26.67	24.71	"	2.16	trace	"

Note. Due to the difficulty of obtaining KCN free of KOH the saturated solutions were prepared from double salts which could be obtained free of KOH. Saturation was reached by constant rotation in wax bottles, in which an atmosphere of coal gas, washed by passing through solutions of lead acetate and sodium hydroxide, was maintained. Both the liquid and solid phases were analyzed.

SOLUBILITY OF SILVER CYANIDE IN ANHYDROUS HYDROGEN CYANIDE
WITH ADDED H₂SO₄ AND HNO₃
(Jander and Grüttner, 1948)

The reactants stood for several hours in a sealed tube; no temperature given. The values were read from the authors' curves.

H ₂ SO ₄ ADDED gms. per liter sat. sol.		HNO ₃ ADDED gms. per liter sat. sol.	
H ₂ SO ₄	AgCN	HNO ₃	AgCN
0.0	0.0	0.0	0.0
9.8	8.0	25.2	2.5
19.6	16.0	63.0	5.5
29.4	24.0	100.8	9.0
39.2	32.5	113.4	11.5
49.0	43.5	126.0	14.5

Ag ARGENTUM

SOLUBILITY OF SILVER CYANIDE IN LIQUID SULFUR DIOXIDE

100 gms. liquid SO_2 dissolve 0.019 gm. AgCN at 0° . (Jander and Ruppolt, 1937.)

Fusion-point data for mixtures of $\text{AgCN} + \text{NaCN}$ are given by Truthe (1912).

SILVER DICYANIMIDE $\text{AgN}(\text{CN})_2$

One liter saturated solution in water contains 0.0064 gm. $\text{AgN}(\text{CN})_2$ at 18° - 20° , determined by the potentiometric method. (Birckenbach and Huttner, 1930.)

SILVER TRICYAN METHYL $\text{AgC}(\text{CN})_3$

One liter saturate solution in water contains 0.013 gm. $\text{AgC}(\text{CN})_3$ at 18° - 20° , determined by the potentiometric method. (Birckenbach and Huttner, 1930.)

SILVER FERRICYANIDE $\text{Ag}_3\text{Fe}(\text{CN})_6$

One liter H_2O dissolves 0.00066 gm. Ag_3FeCN_6 at 20° . (Whitby, 1910.)

SILVER SODIUM CYANIDE $\text{AgCN} \cdot \text{NaCN}$

100 gms. H_2O dissolve 20 gms. at 20° , and more at a higher temperature. 100 gms. 85% alcohol dissolve 4.1 gms. at 20° . (Baup, 1858.)

SILVER THALLOUS CYANIDE $\text{AgCN} \cdot \text{TlCN}$

100 gms. H_2O dissolve 4.7 gms. at 0° , and 7.4 gms. at 16° . (Fronmuller, 1878.)

OCN SILVER CYANATE AgOCN

SOLUBILITY IN WATER

t	gms. per liter sat. sol.	
18° - 20°	0.072	(Birckenbach and Huttner, 1930)
30°	.045*	(Adad, 1954)

*calculated from the activity constant: $2.3 \times 10^{-8} = [\text{Ag}^+][\text{Ag}(\text{OCN})_2^-]f_{\pm}^2$

SILVER FULMINATE $\text{Ag}_2\text{C}_2\text{N}_2\text{O}_2$ SOLUBILITY IN WATER
(Holleman, 1896)

t°	gms. per liter sat. sol.
13	0.075
30	.180

SILVER THIOCYANATE AgSCN

SCN

SOLUBILITY IN WATER

t°	gms. AgSCN per liter	
18	0.00012	(Kirschner, 1912)
	.00017	(Masaki, 1930)
20	.00014	(Böttger, 1903)
21	.00025	(Whitby, 1910)
25	.00017	(Kuster and Thiel, 1903; Cave and Hume, 1953)
	.00018	(Kirschner, 1912)
	.00020	(Abegg and Cox, 1903; Aditya and Prasad, 1952)
100	.0064	(Böttger, 1906)

Also see Hill, 1908

SOLUBILITY OF SILVER THIOCYANATE IN AQUEOUS SOLUTIONS
OF AMMONIA AT 25°
(Gerrick and Wilson, 1932)

Gm. Mols. per 1000 gms. Sat. Solution		Solid Phase	Gm. Mols. per 1000 gms. Sat. Solution		Solid Phase
$[\text{NH}_3]$	$[\text{AgCNS}]$		$[\text{NH}_3]$	$[\text{AgCNS}]$	
1.026	0.00517	AgSCN	3.767	0.02031	$\text{AgSCN} \cdot \text{NH}_3$
1.587	0.00854	"	4.335	0.02284	"
1.840	0.01001	"	4.504	0.02341	"
2.178	0.01234	"	5.27	0.02724	"
2.276	0.01292	"	5.36	0.02771	"
2.440	0.01376	$\text{AgSCN} \cdot \frac{1}{2}\text{NH}_3 \cdot \frac{1}{2}\text{H}_2\text{O} (?)$	6.60	0.03480	"
2.581	0.01454	"	7.35	0.03966	"
2.848	0.01590	"	7.47	0.04062	"
2.915	0.01635	"	8.94	0.0518	"
3.049	0.01734	"	9.91	0.0620	"
3.217	0.01780	$\text{AgSCN} \cdot \text{NH}_3$	11.36	0.0620	"
3.325	0.01842	"	14.69	0.1596	"
3.684	0.01991	"			

The determination of the composition of the solid phases was attended with considerable difficulty and the formula in one case is still uncertain.

Ag ARGENTUM

SOLUBILITY OF SILVER THIOCYANATE IN AgNO_3 SOLUTIONS

t°	moles per liter		
	AgNO_3	AgSCN	
20	0.301	5.0×10^{-5}	(Stubican and Tezak, 1950)
	1.020	7×10^{-4}	(" " " ")
25.2	3	2.6×10^{-4}	(Hellwig, 1900)

SOLUBILITY OF SILVER THIOCYANATE IN AQUEOUS SOLUTIONS OF BARIUM THIOCYANATE AND VICE VERSA AT 25° (Occleshaw, 1934)

SCN

Gms. per 100 gms. Sat. Sol.			Gms. per 100 gms. Sat. Sol.		
$\text{Ba}(\text{SCN})_2$	AgSCN	Solid Phase	$\text{Ba}(\text{SCN})_2$	AgSCN	Solid Phase
9.68	0.75	AgSCN	44.28	31.67	1:2:2
18.18	4.47	"	47.74	29.81	"
21.00	14.67	"	52.04	29.17	" + 1:1:2
32.20	23.24	"	52.61	27.89	1:1:2
34.50	27.99	"	53.23	26.35	"
36.04	33.79	" + 1:3:2	54.14	25.01	"
36.78	34.01	1:3:2	55.20	23.91	"
37.13	34.28	"	55.91	22.98	" + $\text{Ba}(\text{SCN})_2 \cdot 3\text{H}_2\text{O}$
37.49	34.58	"	55.99	22.58	$\text{Ba}(\text{SCN})_2 \cdot 3\text{H}_2\text{O}$
38.41	35.13	"	57.36	17.04	"
39.02	35.79	"	58.91	12.58	"
39.54	35.76	" + 1:2:2	61.39	4.29	"
40.61	34.70	1:2:2	62.61	0.0	"

1.3.2 = $\text{AgSCN} \cdot 3\text{Ba}(\text{SCN})_2 \cdot 2\text{H}_2\text{O}$; 1.2.2 = $\text{AgSCN} \cdot 2\text{Ba}(\text{SCN})_2 \cdot 2\text{H}_2\text{O}$; 1.1.2 = $\text{AgSCN} \cdot \text{Ba}(\text{SCN})_2 \cdot 2\text{H}_2\text{O}$.

EQUILIBRIUM IN THE SYSTEM SILVER THIOCYANATE-
CALCIUM THIOCYANATE-WATER AT 25°
(McKerrow, Occleshaw, and Drabble, 1946)

Gms. per 100 gms. of sat. sol.		Solid Phase	Gms. per 100 gms. of sat. sol.		Solid Phase
AgSCN	Ca(SCN) ₂		AgSCN	Ca(SCN) ₂	
0.0	60.20	α -Ca(SCN) ₂ ·4H ₂ O	31.01	25.15	1:2:2 + AgSCN
4.03	58.80	"	30.70	24.52	AgSCN
7.49	57.05	"	22.88	21.72	"
7.52	57.03	α -Ca(SCN) ₂ ·4H ₂ O +	15.42	19.23	"
8.50	55.21	Ca(SCN) ₂ ·2AgSCN	11.74	17.33	"
8.26	54.74	"·2H ₂ O	8.09	15.01	"
10.27	50.76	"	3.42	14.11	"
13.09	44.99	"			
14.96	41.95	"			
19.22	37.02	"			
25.71	29.12	"			
26.74	27.86	"			
29.79	25.47	"			
Results at 20°					
			0.0	59.00	α -Ca(SCN) ₂ ·4H ₂ O
			4.24	57.27	"
			5.19	56.85	"
			7.50	56.41	"
			8.73	55.44	"

THE SYSTEM SILVER THIOCYANATE - POTASSIUM THIOCYANATE-WATER AT 25°
(Foote, 1903; Occleshaw, 1932) (see also next page)

The data of Foote and Occleshaw are in excellent agreement. In the table below only the invariant points given by Foote are included (bracketed).

gms. per 100 gms. Sat. Sol.		Solid Phase	gms. per 100 gms. Sat. Sol.		Solid Phase
AgSCN	KSCN		AgSCN	KSCN	
1.29	9.67	AgSCN	(20.43)	(50.68)	1:1 + 1:2
6.69	16.97	"	20.57	50.53	1:2
11.39	20.98	"	16.12	55.21	"
16.10	23.15	AgSCN + 1:1	13.06	59.29	"
(16.07)	(23.86)	" + "	9.22	66.31	"
16.68	25.40	1:1	9.19	66.88	1:2 + KSCN
19.24	35.88	"	(9.32)	(66.55)	" + "
20.04	43.02	"	5.12	68.77	KSCN
20.58	50.01	"	0.0	70.89	"
20.56	54.09*	"	(0.0)	(70.53)	"

*metastable 1:1 = AgSCN·KSCN 1:2 = AgSCN·2KSCN

Ag ARGENTUM

The System AgSCN - KSCN - H₂O, Continued

Data of Hellwig, 1900
(25°), Stubican and Tezak
1950 (20°), Kratochvil and
Tezak, 1950 (20°).
See p. 57 for the method
of K.&T.

Data of Randall
and Halford, 1930
and Cave and Hume,
1953* at 25°

t°	moles per liter		moles per 1000 gms. H ₂ O	
	KSCN	AgSCN	KSCN	AgSCN
SCN 20°	0.01	0.000007(ST)	0.00548	1.62 x 10 ⁻⁶
	.0795	.0001	0.01033	3.65 x 10 ⁻⁶
	.108	.0002	0.04133	3.00 x 10 ⁻⁵
	.1538	.0004	0.08885	1.39 x 10 ⁻⁴
	.179	.0006	0.1334	3.56 x 10 ⁻⁴
	.2025	.001	0.2224	0.00128
	.276	.002	0.312	0.00202(R&H)
	.36	.004	0.3343	0.00370
	.42	.006	0.5572	0.0146
	.485	.01	0.564	0.0121(R.&H.)
	.648	.02	0.7783	0.0376
	.84	.04	0.870	0.0458(R.&H.)
	.95	.06	1.114	0.0981
	1.00	.10(ST)	1.124	0.0985(R.&H.)
	1.205	.1	1.688	0.2684
	25°	0.573	2.252	0.5061
	0.626	0.0124		
	1.066	0.0168		
	1.12	0.0850		
	1.20	0.0975		
	1.20	0.120		
	1.25	0.134		

*Cave and Hume's deter-
minations were made at
constant ionic strength
(=2.2) by addition of KNO₃.
The values above were se-
lected from their tables.

THE SYSTEMS

SILVER THIOCYANATE - SODIUM THIOCYANATE - WATER

SILVER THIOCYANATE - AMMONIUM THIOCYANATE - WATER AT 25°
(Occlesshaw, 1932)

AgSCN - NaSCN - H ₂ O at 25°			AgSCN - NH ₄ SCN - H ₂ O at 25°		
Gms. per 100 gms. Sat. Solution			Gms. per 100 gms. Sat. Solution		
AgSCN	NaSCN	Solid Phase	AgSCN	NH ₄ SCN	Solid Phase
1.74	9.19	AgSCN	3.19	10.66	AgSCN
10.09	17.55	"	14.92	19.57	"
12.61	17.24	" + 1.1.2	30.88	26.86	"
11.06	25.42	1.1.2	35.09	28.19	" + 1.1
11.14	38.31	"	34.10	31.10	1.1
11.21	42.49	"	33.44	36.04	"
11.53	48.51	"	33.29	40.25	"
12.68	54.36	"	33.14	44.27	"
12.72	54.34	" + 1.3	33.18	45.13	" + 1.5
12.54	54.46	1.3	30.88	46.18	1.5
12.23	54.78	"	24.80	48.22	"
12.21	54.80	" + NaSCN	17.16	51.42	"
9.80	55.42	NaSCN	9.46	57.07	"
5.09	56.94	"	4.48	62.87	" + NH ₄ SCN
0.0	58.78	"	3.19	63.37	NH ₄ SCN
			0.0	64.33	"

1.1.2 = AgSCN·NaSCN·2H₂O

1.3 = AgSCN·3NaSCN

1.1 = AgSCN·NH₄SCN1.5 = AgSCN·5NH₄SCN

SOLUBILITY IN METHANOL

The solubility Product of AgSCN in CH₃OH at 25° in equiv. gm. per 1000 gm. CH₃OH is 1.8×10^{-14} ; Buckley and Hartley, 1929.

SOLUBILITY OF SILVER THIOCYANATE IN POTASSIUM THIOCYANATE SOLUTIONS
IN AQUEOUS METHANOL, ETHANOL AND ACETONE SOLUTIONS AT 20°
(Kratohvil and Tezak, 1954)

KSCN was added to AgNO₃ solutions until the turbidity of AgSCN just disappeared. The solution therefore also contained KNO₃ equal to the amount of AgSCN dissolved. The dielectric constant D of each solvent is listed. All concentrations are given in moles per liter, solvents in weight percent. For similar solubilities in pure water, see page 56.

Ag ARGENTUM

AgSCN	KSCN						
	Methanol 62% D = 50.4	Ethanol				Acetone	
		30% 62.6	50% 50.4	70% 39.1	90% 29.0	48.5% 50.4	82% 29.0
.06	...	...	0.84	...	...	...	...
.04	...	...	0.68	...	...	...	...
.02	...	...	0.49	...	...	...	...
.01	0.36	0.43	0.35	0.285	...	0.205	0.102
.006	...	...	0.285	...	...	...	0.075
.004	...	0.29	0.23	0.19	...	0.125	0.0525
.002	...	...	0.165	...	...	...	0.031
.001	0.115	0.145	0.11	0.0825	0.058	0.058	0.019
.0006	...	...	0.082	...	.04	...	0.0115
.0004	0.0625	0.0925	0.0615	0.0455	.029	0.03125	0.0077
.0002	...	...	0.037	...	.0165	...	0.00365
.0001	0.023	0.0425	0.022	0.01375	.0091	0.0095	0.001675
.00006	...	...	0.0135	...	.005	...	0.000875
.00004	0.0095	0.021	0.00875	0.0048	.00345	0.0040	0.000575
.00002	0.0044	0.0115	0.00385	0.0021	.00145	0.001625	0.00023
.00001	0.00175	0.00575	0.001375	0.0009	.00062	0.000725	0.0000875

SOLUBILITY IN LIQUID SULFUR DIOXIDE

100 gms. liquid sulfur dioxide dissolve 0.014 gm. AgSCN at 0°.
(Jander and Wickert, 1936; Jander and Ruppold, 1937.)

SeCN SILVER SELENOCYANATE AgSeCN

Using the cell Ag|AgCNSe, KCNSe|KNO₃|AgNO₃|Ag Watkins and McCrosky (1946) determined the solubility product of Silver Selenocyanate to be 6.9×10^{-15} at $25 \pm .1^\circ$.

CO SILVER CARBONATE Ag₂CO₃

SOLUBILITY IN WATER

t°	gms. Ag ₂ CO ₃ per liter	Author
15	0.031	(Kremers, 1852)
	0.85 in H ₂ O sat'd. with CO ₂	(Johnson, 1886)
18	0.03	(Masaki, 1930)
	1.05* in contact with 1 atm. CO ₂	(Haehnel, 1924)
	1.70* " " " 56 atm. CO ₂	(")
25	0.033	(Abegg & Cox, 1903)
	0.032	(Spencer and LePla, 1909)
	1.15* in contact with 0.944 atm. CO ₂	(Walker, Bray & Johnston, 1927)

*gms. Ag₂CO₃ per 1000 gms. sat. sol.

SILVER OXALATE $\text{Ag}_2\text{C}_2\text{O}_4$

C0

SOLUBILITY IN WATER

t°	gms. $\text{Ag}_2\text{C}_2\text{O}_4$ per liter	Author
9.72	0.0265	(Kohlrausch, 1908)
18	.0342	(Scholder, Gadenne and Niemann, 1927)
18.5	.034	(Kohlrausch, 1908)
21	.0378	(Whitby, 1910)
25	.0416	(Schäfer, 1905)
	.0404	(Barney, Argersinger, and Reynolds, 1951)

SOLUBILITY OF SILVER OXALATE IN AQUEOUS NITRIC ACID AT 25°
(Hill and Simmons, 1909)

Normality of Aq. HNO_3	Percent Conc. of HNO_3	d ₂₅ of Sat. Sol.	Gms. $\text{Ag}_2\text{C}_2\text{O}_4$ per liter
0.2517	1.574	1.0080	1.345
0.5025	3.117	1.0186	2.189
0.9806	6.017	1.0339	3.720
1.040	11.476	1.0647	7.170
4.017	22.37	1.1415	17.11
5.564	29.84	1.1996	29.96
5.83	31.085	1.2162	33.88

SOLUBILITY IN POTASSIUM OXALATE SOLUTION:

2.5×10^{-15} moles $\text{Ag}_2\text{C}_2\text{O}_4$ dissolve in a liter of 0.035 M $\text{K}_2\text{C}_2\text{O}_4$ solution. (Barney, Argersinger, and Reynolds, 1951.)

SILVER CHLORIDE AgCl

C1

SOLUBILITY OF SILVER CHLORIDE IN WATER

The results of the determinations of the solubility of silver chloride in water at various temperatures and by such different methods as direct gravimetric analysis, conductometric, colorimetric, nephelometric, photometric (Tyndallometric) and potentiometric, as reported by the following investigators, were plotted on cross section paper and from the average curve so obtained, the values given below were read.

The limits of variation in the results at 25° were from 0.00165 to 0.00218 gms. AgCl per liter, but most of the recent data agree well with the average listed (± 0.00003).

Ag ARGENTUM

(Thiel, 1900)	(Scott and Johnson, 1930)
(Abegg and Cox, 1903)	(Hahn and Klockmann, 1930)
(Böttger, 1903, 1906)	(Popoff and Neuman, 1930)
(Kohlrausch, 1904, 1908)	(Neuman, 1932)
(Hill, 1908)	(Eversole and McLachlan, 1932)
(Whitby, 1910)	(Dave and Krishnaswami, 1933)
(Melcher, 1910)	(Bedell, 1937)
(V. Rossum, 1912)	(Owen, 1938)
(Glowczynski, 1914)	(Barney, Argersinger and Reynolde, 1951)
(Lorenz and Bergbeimer, 1924)	(Davies and Jones, 1949, 1955)
(Pinkus and Martin, 1927)	(Gledhill and Malan, 1952)
(Pinkus and Berlolaiko, 1930)	(Guggenheim and Prue, 1954)
(Koch, 1930)	

Cl

The data above 200° are those of Gavrish and Galinker, 1955

t°	Gms. AgCl per liter	t°	Gms. AgCl per liter	t°	Gms. AgCl per liter
0	0.00070	40	0.0036	299	0.310
5	0.00085	45	0.0043	309	0.327
10	0.00105	50	0.0054	319	0.340
15	0.00125	100	0.021	329	0.340
20	0.00155	220	0.180	339	0.390
25	0.00193 *	250	0.250	349	0.450
30	0.0024	269	0.270	354	0.700
35	0.0029	289	0.304	359	0.840

Johnson and Hulett, 1933, showed that samples of silver chloride prepared by precipitation and washing by different procedures, and then used for solubility determinations, yielded saturated solutions in which a varying excess of Cl was present. This is apparently a case of absorption equilibrium and places limitations upon the interpretation of the results of solubility determinations.

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

0° (Erber and Schuhly, 1941)			20° (Jaques, 1946; Dede & Walther, 1927)			
moles per liter	den- sity	Sol.	Solvent moles HCl per liter	gms. AgCl per 1000 gms. Solvent	Solvent moles HCl per liter	gms. AgCl per 1000 gms. solvent
HCl	AgCl	Sol.				
6.48	0.00563	1.1026	0.607	0.0036	5.30	0.440
7.23	.00807	1.1149	1.274	.0135	5.83	0.588
8.78	.01466	1.1393	1.79	.0246(D.&W.)	7.79	1.416
10.20	.01949	1.1606	2.63	.0632(D.&W.)	9.10	2.233
10.90	.02159	1.1714	2.814	.0771	10.52	3.209
12.06	.02237	1.1909	3.984	.1899	11.03	3.588
12.19	.02169	1.1911	5.00	.396 (D.&W.)	11.72	4.114
12.55	.02191	1.1914			12.97	5.129

25°

(Forbes, 1911; Forbes and Cole, 1921; Pinkus and Timmermans, 1937;
Erber and Schuhly, 1941)

- results in moles per liter -

HCl		AgCl		HCl		AgCl		HCl		AgCl		Density Sat. Sol. (data of E. & H.):	
0.0001	0.277 x 10 ⁻⁵	(P.T.)		0.649	3.2 x 10 ⁻⁵	(F.)							
.001	.097	"	(P.T.)	.6818	4.48	"	(F.C.)						
.0025	.045	"	(P.T.)	.7797	5.54	"	(F.C.)						
.00478	.075	"	(F.C.)	.9258	7.19	"	(F.C.)						
.00938	.084	"	(F.C.)	1.00	7.45	"	(P.T.)	6.46	0.00781	1.1033			
.010	.097	"	(P.T.)	1.300	12.6	"	(F.)	6.47	.00811	1.1029			
.0178	.125	"	(F.C.)	1.911	26.6	"	(F.)	7.26	.01139	1.1157			
.0341	.219	"	(F.C.)	2.149	37.4	"	(F.)	8.76	.01970	1.1397			
.0741	.361	"	(F.C.)	2.975	81.4	"	(F.)	10.20	.02727	1.1616			
.0914	.426	"	(F.C.)	3.576	135.8	"	(F.)	10.94	.03049	1.1730			
.10	.302	"	(P.T.)	4.182	214.7	"	(F.)	10.75	.02964	1.1726			
.3167	1.403	"	(F.C.)	4.735	316.8	"	(F.)	12.15	.03091	1.1901			
.50	2.25	"	(P.T.)	5.508	512.6	"	(F.)	12.11	.03121	1.1893			

Cl

Fomin, 1953 gives the equation $S = 4.2 \times 10^{-5} [Cl^-] + 5.4 \times 10^{-7}$ for the solubility of AgCl in HCl solutions at 25°. (S = moles AgCl per liter, $[Cl^-]$ = initial chloride concentration.)

Data of Dede and Walther, 1927 at higher temperatures:

- grama AgCl per 100 gms. solvent -

Solvent:	20° (also listed above)	40°	60°	80°
wt. % HCl				
6.32	0.00246	0.00561	0.0115	0.0224
9.19	.00632	.0126	.0239	.0433
16.84	.0396	.0634	.1001	.1512

Further data on the solubility in HCl solutions is given by Whitby, 1910 (at 21°) and by Pierre, 1847 and Vogel 1867, 1874 at "ordinary temperature" and "the boiling point." ["5.60 gms. AgCl dissolve in a liter of saturated HCl (Sp. gr. 1.165) at the boiling point"]. For data in solutions containing HCl + NaCl, see Barlow, 1906.

SOLUBILITY OF SILVER CHLORIDE IN NITRIC ACID SOLUTIONS

The data of Dave and Krishnaswami (1933) are in reasonable agreement with those of Scott and Johnson (1933) (done at + 0.5°). Those of Johnson and Law, Jr. (1933) are too low.

0°	Data of Dave and Krishnaswami at 0° moles per liter		Data of Scott and Johnson at +0.5° moles per liter	
	HNO ₃	AgCl	HNO ₃	AgCl
	0.11	6.0 x 10 ⁻⁶	0.0	5.0 x 10 ⁻⁶
	.48	7.1 "	.11	6.3 "
	.81	7.7 "	.24	7.0 "
	1.00	7.9 "	.49	7.1 "
			.99	7.3 "

Ag ARGENTUM

	moles per liter		
	HNO ₃	AgCl	
8°	0.48	0.89×10^{-5}	} Dave and Krishnaswami, 1933
18°	0.48	1.38×10^{-5}	

25° At low concentrations of HNO₃ the data of Pinkus and Shepmans (1938), Popoff and Neuman (1930), and Neuman (1932) agree. Those of Glowczynski (1914) are too low. At higher HNO₃ concentrations (> 0.1 M) the data of Dave and Krishnaswami (1933) agree with those of Glowczynski (1914), but those of Pinkus and Shepmans (1938) are considerably higher. The results of Eversole and McLaughlin, 1932 are rather erratic.

C1

moles per liter			moles per liter		
HNO ₃	AgCl		HNO ₃	AgCl	
1.279×10^{-5}	1.279×10^{-5}	(P.&S., N.)	0.48	1.64×10^{-5}	(D.K.)
5.282 "	1.284 "	(P.&S.)	0.81	1.68 "	(D.K.)
1.127×10^{-4}	1.290 "	(P.&S.)	1.00	1.74 "	(D.K.)
2.865 "	1.300 "	(P.&S.)	1.50	1.71 "	(G.)
5.133 "	1.308 "	(P.&S.)	Results of Pinkus and Shepmans:		
7.233 "	1.318 "	(N.)			
1.014×10^{-3}	1.323 "	(P.&S.)			
2.864 "	1.352 "	(N.)			
4.009 "	1.372 "	(P.&S.)	0.04369	1.583×10^{-5}	
5.695 "	1.387 "	(N.)	0.1086	1.722 "	
9.009 "	1.422 "	(N.)	1.094	2.308 "	
1.000×10^{-2}	1.427 "	(P.&S.)	2.519	2.530 "	
0.11	1.51 "	(D.&K.)	5.139	2.696 "	
0.30	1.57 "	(G.)	8.804	2.743 "	

	moles per liter		
	HNO ₃	AgCl	
30°	0.48	1.84×10^{-5}	} Dave and Krishnaswami, 1933
40°	0.48	3.98×10^{-5}	
50°	0.48	7.69×10^{-5}	

SOLUBILITY OF SILVER CHLORIDE IN VERY DILUTE SULFURIC ACID SOLUTIONS

AT 25°

(Popoff and Neuman 1930, Neuman, 1932)

The determinations were made nephelometrically with the highest attainable accuracy.

moles per liter		moles per liter	
H ₂ SO ₄	AgCl	H ₂ SO ₄	AgCl
0.0064×10^{-3}	1.278×10^{-5}	3.107×10^{-5}	1.420×10^{-5}
0.0364 "	1.289 "	5.402 "	1.485 "
0.2065 "	1.310 "	7.021 "	1.515 "
0.7067 "	1.340 "	9.179 "	1.535 "
1.507 "	1.371 "	10.794 "	1.551 "
2.207 "	1.384 "	13.495 "	1.580 "

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS HYDROCYANIC ACID AT 25°
(Randall and Halford, 1930)

This system was studied as a case of equilibrium in a chemical reaction involving formation of a complex ion. The assumed reaction is $\text{AgCl(s)} + 2\text{HCN(aq.)} = \text{Ag(CN)}_2^- + 2\text{H}^+ + \text{Cl}^-$. The results of the analyses of the saturated solutions are expressed in molalities.

m (HCN(aq.))	m (Acid)	m (Complex)	m (Chloride)
0.0938	0.00303	0.00132	0.00161
0.1831	0.00430	0.00182	0.00258
0.2292	0.00493	0.00199	0.00294

Cl

MIXTURES OF SILVER CHLORIDE AND SILVER HYDROXIDE IN
EQUILIBRIUM WITH AQUEOUS POTASSIUM HYDROXIDE SOLUTIONS AT 25°
(Noyes and Kohr, 1902)

Normality of KOH	Millimols per liter		Grams per liter		
	KCl	KOH	KCl	KOH	AgCl
0.333	3.414	347.8	0.255	10.05	0.4896
0.065	0.598	65.0	0.0446	2.00	0.0828

Further data for the equilibrium $\text{Ag}_2\text{O} + 2\text{Cl}^- + \text{H}_2\text{O} \rightleftharpoons 2\text{AgCl} + 2\text{OH}^-$ (using KOH and KCl) at 25° are given by Newton, 1928.

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS AMMONIA SOLUTIONS

0° (Jarry, 1899) gms. per 100 gms. sat. sol.		15° (Bödländer, 1892) moles per liter		density Sat. Sol.
NH ₃	AgCl	NH ₃	AgCl	
1.45	0.49	0.639	0.0348	1.0015
2.94	1.36	1.040	.0640	1.0010
5.60	3.44	1.223	.0746	1.0035
6.24	4.00	1.462	.0976	1.0033
11.77	4.68	1.514	.1022	1.0040
16.36	5.18	1.784	.1224	1.0046
28.16	6.50	2.449	.1870	1.0053
29.80	7.09	2.810	.2256	1.0070
30.19	7.25	3.608	.3052	1.0135
32.43	5.87	3.802	.3348	1.0145
34.56	4.77	3.975	.3620	1.0150
37.48	3.90	4.273	.3928	1.0167
		4.718	.4726	1.0225
		5.498	.5060	1.0220
		10.603	.5270	0.9875

Ag ARGENTUM

25°

Bödländer and Fittig, 1902
Straub, 1911
Randall and Halford, 1930

moles per 1000 gms. H ₂ O			moles per 1000 gms. H ₂ O		
NH ₃	AgCl		NH ₃	AgCl	
0.0428	0.025	(S)	2.6400	0.2151(R.&H.)	
..0942	.004592		2.8393	.2254(B.&F.)	
.10065	.005164	(B.&F.)	2.9091	.2395(R.&H.)	
.1033	.005343		3.7574	.3438(B.&F.)	
.1089	.005665	(R.&H.)	3.782	.372 (S)	
.2084	.01137		3.945	.378 (S)	
.2947	.01588		4.6918	.4680(B.&F.)	
.4881	.02588	(B.&F.)	5.10	0.574	
.7522	.04758		5.33	0.609	
.9663	.06118		5.545	0.633	
1.3039	.0895	(R.&H.)	6.26	0.754*	
1.688	.1308	(S)	6.52	0.775**	
1.7100	.1256	(R.&H.)	8.28	0.848**	
1.8782	.1379	(R.&H.)	11.78	0.980**	
1.9004	.1362	(B.&F.)	12.68	1.030**	
2.1339	.1628	(R.&H.)	12.96	1.090**	
			14.47	1.039**	

Whitney
and
Melcher, 1903

moles per liter	
NH ₃	AgCl
0.0282	0.00141
0.0288	0.00149
0.0590	0.00304
0.118	0.00621
0.253	0.0140
0.397	0.0227
0.428	0.0249
0.818	0.0514
0.863	0.0541
0.896	0.0569
0.909	0.0584
0.961	0.0616
1.991	0.147
2.042	0.151

*Solid phase AgCl + 2AgCl·3NH₃**Solid phase 2AgCl·3NH₃

Other temperatures:

A few results for other temperatures are given by Longi, 1883 (12°, 18°); Bödländer and Fittig, 1902 (16, 17, 18, 19°); Valenta, 1894 (25°); Pohl, 1860 (80°).

SOLUBILITY OF SILVER CHLORIDE IN AMMONIA SOLUTIONS CONTAINING OTHER SALTS AT 25°

Silver Nitrate			Added Salt:			Potassium Nitrate		
(Bödländer and Fittig, 1902)			Potassium Chloride			(Derr, Stockdale and Vosburgh, 1941)		
moles per 1000 gms. H ₂ O			(Bödländer and Fittig, 1902)			(Derr, Stockdale and Vosburgh, 1941)		
			(Derr, Stockdale and Vosburgh, 1941(*))			moles per 1000 gms. H ₂ O		
			moles per 1000 gms. H ₂ O					
NH ₃	AgNO ₃	AgCl	NH ₃	KCl	AgCl	NH ₃	KND ₃	AgCl
.7522	0	0.04758	0.7477	0.0102	0.04392	0.08905	0.0	0.004538
.7517	.01021	.04173	0.7458	.0255	.03869	.08731	.0534	.005209
.7503	.02556	.03503	0.7497	.0511	.03330	.08232	.1057	.005203
.7550	.05129	.02751	2.013	0.0	.1511*	.08961	.1638	.005948
			0.3707	.0106	.01724*	.08821	.335	.006442
			0.3495	.0312	.01143*	.08735	.604	.006768
			0.2988	.3222	.002958*			

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF
METHYLAMINE AND ETHYLAMINE

(Jarry, 1899; Bodlander and Eberlein, 1903; Wuth, 1902; Euler, 1903)

Methylamine				Ethylamine		
11.5° (Jarry)		25°		25°		
gms. per 100 gms. sat. sol.		moles per liter		moles per liter		
CH ₃ NH ₂	AgCl	CH ₃ NH ₂	AgCl	C ₂ H ₅ NH ₂	AgCl	Cl
1.78	0.16	1.017	0.0387(B.&E.)	0.483	0.0314 (B.&E.)	Cl
4.44	0.62	0.93	0.0335(E.)	0.200	0.0115 "	"
5.51	0.83	0.508	0.0178(B.&E.)	0.100	0.0062 "	"
7.66	1.32	0.203	0.0068 "	0.094	0.0048 (E.)	"
13.70	3.29	0.102	0.0036 "	0.050	0.0029 (B.&E.)	"
18.69	5.43	0.195	0.00048(W.)	0.103	0.00824 (W.)	"
36.69	9.93	0.074	0.00042 "	0.0551	0.000235 "	"
		0.020	0.00030 "	0.0127	0.000114 "	"

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS
OF SILVER NITRATE AT 25°

(Pinkus, Frederic and Shepmans, 1938)

Fine suspensions of colloidal silver chloride in aqueous solutions of silver nitrate prepared from measured amounts of solutions of AgNO₃, of NaCl and of water were agitated in sealed tubes and after attainment of equilibrium, the presence of excess of AgCl was determined by the opalescence or tyndalometric method.

Gm. Mols. per liter		Gm. Mols. per liter	
AgNO ₃	AgCl	AgNO ₃	AgCl
0.00005	0.000284	0.05	0.00017
0.00010	0.000143	0.10	0.00029
0.00030	0.0000063	0.20	0.00055
0.0010	0.0000043	0.40	0.00121
0.0050	0.0000037	0.7986	0.00329
0.0100	0.0000049	0.9983	0.00486
		3.0	0.0056*

*Hellwig, 1900

SOLUBILITY OF SILVER CHLORIDE ON AQUEOUS SOLUTIONS OF CHLORIDES
(see pp. 60, 61 for data on HCl solutions)

- (1) Forbes, 1911 (mixed solutions until opalescence appeared)
 (2) Hahn, 1877
 (3) Forbes and Cole, 1921 (mixed solutions until opalescent)
 (4) Dede and Walther, 1927
 (5) Schierholz, 1890
 (6) Pinkus and Timmermans, 1937 (equilibrated solutions were filtered and analyzed nephelometrically)
 (7) Barney, Argersinger and Reynolds, 1951 (radioactive tracer assay)
 (8) Pinkus and Haugen, 1936; Pinkus and Berkolaiko, 1930 (solutions concentrated electrolytically and then analyzed nephelometrically)
- C1
- (9) Barlow, 1906
 (10) Hellwig, 1900
 (11) Kendall and Sloan, 1925
 (12) Valenta, 1894
 (13) Glowczynski, 1914 (solutions evaporated and titrated with thiocyanate)
 (14) Jonte and Martin, 1952 (radioactive tracer assay. Used varying amounts of HClO_4 to keep roughly constant ionic strength pH and of sat'd. sol'ns. given in paper)

See also Langdon, 1923-24.

concentration of			Ref.	concentration of			Ref.
t°	Salt	AgCl		t°	Salt	AgCl	
<u>Results with BaCl₂</u>				<u>Results with CaCl₂ (Cont.)</u>			
	wt. %				moles per liter		
24.5°	27.32	0.057	(2)	25°	1.869	.002184	(1)
	moles per liter				2.017	.002802	
					2.269	.004175	
25°	0.0188	0.00000157	(3)	35°	1.611	.001806	
	0.624	.000186	(1)		wt. %		
	0.805	.000339		40°	9.31	0.00656	(4)
	1.338	.001274			13.3	.01575	
	1.630	.002366			23.6	.0976	
	<u>Results with CaCl₂</u>				37.9	.584	
	moles per liter			60°	9.31	.0132	(4)
1°	1.756	0.000964	(1)		13.3	.0290	
	wt. %				23.6	.147	
20°	9.31	0.00320	(4)	80°	37.8	.741	
	13.3	.00855			9.31	.0251	(4)
	23.6	.0667			13.3	.0499	
	37.9	.443			23.6	.251	
24.5°	41.26	.571	(2)		37.7	.957	
	moles per liter				<u>Results with CuCl₂</u>		
25°	0.0198	0.00000175	(3)	24.5°	Saturated	0.053	(2)
	0.874	.000289	(1)		<u>Results with KCl</u>		
	1.101	.000501			moles per liter		
	1.371	.000900		1°	3.325	0.001734	(1)
	1.632	.001463					
	1.660	.001514					

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF CHLORIDES--Cont.

concentration of			Ref.	concentration of			Ref.
t°	Salt	AgCl		t°	Salt	AgCl	
<u>Results with KCl</u>				<u>Results with LiCl</u>			
	wt. %				wt. %		
15°	10.0	0.000	(5)	20°	7.27	0.00246	(4)
	14.29	.004			10.52	.00609	
	16.66	.008			19.93	.0410	
	20.00	.020			31.9	.307	
	22.47	.045					
	24.0	.072					
	25.0	.084					
19.6°	24.95	0.0776	(2)				
20°	12.11	0.00410	(4)				
	17.14	.0137	(4)				
	moles per liter				moles per liter		
25°	0.28×10^{-4}	8.94×10^{-6}	(6)	25°	0.28×10^{-4}	2.77×10^{-6}	(6)
	0.316 "	12.8 "	(13)		0.50 "	0.60 "	
	0.50 "	4.78 "	(6)		1.0 "	0.43 "	
	0.632 "	15.2 "	(13)		0.001 "	0.49 "	
	1.0 "	2.77 "	(6)		0.0025 "	2.90 "	(6)
	2.0 "	21.3 "	(13)		0.010 "	22.1 "	
	4.0 "	22.4 "	(13)		0.10 "	71.5 "	
	10. "	0.47 "	(6)		0.44 "	0.100×10^{-3}	
	10. "	0.317 "	(8)		0.50 "	.0221 "	(6)
	15.0 "	0.155 "	(7)		1.00 "	.0715 "	
	25.0 "	0.37 "	(6)		1.24 "	.180 "	
	0.010 "	0.46 "	(6)		1.65 "	.281 "	
	.0100 "	0.401 "	(8)		2.10 "	.605 "	(11)
	.010 "	0.4 "	(7)		2.44 "	1.010 "	
	.035 "	1.72 "	(3)		2.74 "	1.480 "	
	.10 "	2.82 "	(6)		3.01 "	2.458 "	
	.100 "	2.75 "	(8)		3.30 "	3.278 "	(11)
	.250 "	7.73 "			3.40 "	3.925 "	
	.500 "	24.3 "			3.60 "	5.084 "	
	.50 "	25.7 "			3.75 "	5.922 "	
	1.00 "	1.005×10^{-4}	(6)		3.78 "	6.000 "	
	1.111 "	1.41 "	(6)	40°	7.27	0.00561	(4)
	1.425 "	2.35 "			10.52	.01281	
	1.713 "	3.91 "			19.93	.0700	
	2.022 "	6.16 "			31.9	.451	
	2.396 "	10.50 "	(1)	60°	7.27	.01182	(4)
	2.628 "	13.90 "			10.52	.0253	
	2.850 "	18.45 "			19.92	.1112	
	3.081 "	24.35 "			31.8	.622	
	3.424 "	36.02 "	(10)	80°	7.27	.0235	(4)
	3.843 "	57.25 "			10.52	.0465	
	4. "	63.7 "			19.90	.1817	
	4. "	63.7 "			31.7	.849	
35°	2.955	27.86 "	(1)				
	wt. %				wt. %		
40°	12.11	0.00857	(4)	24.5°	35.36	0.531	(2)
	17.14	.0241		25°	33.3	0.50	(12)
60°	12.11	.01680					
	17.14	.0431					
80°	12.11	.0318	(4)				
	17.14	.0741					
	moles per liter				moles per liter		
	1.30	0.580×10^{-3}	(11)		1.30	0.580×10^{-3}	(11)
	1.43	0.768 "			1.43	0.768 "	
	1.67	1.165 "			1.67	1.165 "	
	1.92	1.773 "			1.92	1.773 "	

See also Langdon, 1923, 1924 for data on KCl

Ag ARGENTUM

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF CHLORIDES--Cont.

concentration of			Ref.	concentration of			Ref.
t°	Salt	AgCl		t°	Salt	AgCl	
Results with MgCl ₂ (Cont.)				Results with NH ₄ Cl			
	moles per liter				wt. %		
25°	2.10	2.345 x 10 ⁻³	(11)	90°	26.31	.592	(5)
	2.15	2.530 "		100°	26.31	.711	
	2.29	3.138 "		110°	26.31	.856	
	2.33	3.338 "			26.31	1.053	
	2.46	4.042 "		Results with NaCl			
	2.68	5.264 "			moles per liter		
Results with NH ₄ Cl				15°	5.5 x 10 ⁻⁵	19. x 10 ⁻⁷	(14)
	wt. %				1.1 x 10 ⁻⁴	9.0 "	
15°	10	0.0050	(5)		5.5 x 10 ⁻⁴	3.2 "	
	14.20	.0143			1.1 x 10 ⁻³	2.6 "	
	17.70	.0354			5.5 x 10 ⁻³	2.6 "	
	19.23	.0577			1.1 x 10 ⁻²	3.4 "	
	21.91	.110			5.5 x 10 ⁻²	10. "	
	25.31	.228			1.1 x 10 ⁻¹	18. "	
	26.31	.276	(4)		wt. %		
20°	9.01	.00442			10.0	0.0025	(5)
	12.94	.0134			14.29	.0071	
	22.9	.121	(2)		18.18	.0182	
24.5°	28.45	.340			21.98	.0439	
					23.53	.0706	
					25.64	.103	
	moles per liter				26.31	.127	
25°	9.91 x 10 ⁻⁶	0.0000112	(13)	19.6°	25.95	0.105	(2)
	9.91 x 10 ⁻⁵	.0000116		20°	19.96	0.00921	(4)
	0.513	.000042			24.50	.0764	
	0.926	.000113			moles per liter		
	1.141	.000172			0.586	1.3 x 10 ⁻⁵	(9)
	1.574	.000365			0.787	1.7 "	
	2.143	.000842	(9)		0.984	3.3 "	
	2.566	.001425			1.311	8.7 "	
	2.918	.002160			1.97	21.6 "	
	3.162	.002795			2.62	62.8 "	
	3.510	.004029			3.93	218. "	
	4.363	.009353	(4)	25°	5 x 10 ⁻⁵	5.4 x 10 ⁻⁶	(14)
	4.777	.0135			1.0 x 10 ⁻⁴	2.0 "	(14)
	4.902	.01492				2.7 "	(6)
	5.503	.02404			5 x 10 ⁻⁴	0.69 "	(14)
	5.764	.03017			1.0 x 10 ⁻³	0.52 "	(14)
						0.38 "	(8)
40°	9.01	0.00885	(4)			0.47 "	(6)
	12.94	.0237			2.5 x 10 ⁻³	0.285 "	(8)
	22.9	.178				0.37 "	(6)
	26.31	.329	(5)		5 x 10 ⁻³	0.58 "	(14)
60°	9.01	0.01710				0.75 "	(13)
	12.94	.0411			1.0 x 10 ⁻²	0.66 "	(14)
	22.8	.258	(5)			0.475 "	(8)
	26.31	.421				0.47 "	(6)
80°	9.01	0.0319				0.96 "	(3)
	12.94	.0720	(4)				
	22.8	.370					

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF CHLORIDES--Cont.

t°	concentration of		Ref.	t°	concentration of		Ref.
	Salt	AgCl			Salt	AgCl	
Results with NaCl (Cont.)				Results with NaCl			
moles per liter				wt. %			
25°	5 x 10 ⁻²	1.7 x 10 ⁻⁶	(14)	40°	14.	0.014	(5)
		2.2 "	(3)		19.96	.01727	(4)
	0.10	3.8 "	(14)		24.49	.1149	(4)
		2.99 "	(8)		26.3	.158	(5)
		2.92 "	(6)	50°	14.	.023	
		5.0 "	(3)		26.3	.184	
	0.356	17.4 "	(3)	moles per liter			Cl
	0.365	18.9 "	(3)		0.586	1.1 x 10 ⁻⁴	
	0.50	24.1 "	(6)		0.787	1.7 "	
	0.50	25.0 "	(8)		0.984	2.4 "	(9)
	0.511	28.0 "	(3)		1.311	4.1 "	
	0.90	99. (?) "	(11)		1.97	8.7 "	
	0.933	86 "	(9)		2.62	13.3 "	
	0.975	80.6 "	(3)		3.93	62.1 "	
	1.000	84.5 "	(6)	wt. %			
		87.3 "	(8)		19.96	0.0321	(4)
	1.10	0.131 x 10 ⁻³	(1, 11)	60°	24.47	0.1730	
	1.90	0.130 "		70°	14.	0.042	(5)
	1.39	0.183 "			26.3	0.263	
	1.433	0.184 "		80°	14.	0.054	(4)
	1.61	0.253 "			19.96	0.0571	
	1.617	0.245 "			24.45	0.265	(5)
	1.871	0.348 "		90°	26.3	0.315	
	1.93	0.391 "			14.	0.069	(5)
	2.22	0.542 "			26.3	0.368	
	2.27	0.570 "		moles per liter			
	2.658	0.851 "			0.586	4.7 x 10 ⁻⁴	(9)
	2.841	1.040 "			0.787	7.0 "	
	2.87	1.000 "			0.984	9.4 "	
	3.16	1.366 "			1.311	16.5 "	
	3.270	1.583 "			1.97	30.4 "	
	3.471	1.897 "			2.62	51.1 "	
	3.747	2.462 "	(1, 11)		3.93	119.0 "	
	3.82	2.491 "		wt. %			
	3.977	2.879 "			14.	0.090	(5)
	4.363	3.810 "		100°	26.3	0.460	
	4.39	3.825 "		104°	14.	0.107	(5)
	4.535	4.298 "			26.3	0.571	
	4.81	5.104 "		107°			
	5.00	5.882 "		(b.pt.)			
	5.039	6.039 "					
wt. %							
30°	14.	0.011	(5)				
	26.3	0.132					
moles per liter							
35°	6.42 x 10 ⁻⁵	9.3 x 10 ⁻⁶	(14)				
	1.15 x 10 ⁻⁴	5.0 "					
	5.52 x 10 ⁻⁴	1.7 "					
	1.10 x 10 ⁻³	1.2 "					
	5.50 x 10 ⁻³	1.1 "					
	1.10 x 10 ⁻²	1.4 "					
	5.50 x 10 ⁻²	3.9 "					
	1.10 x 10 ⁻¹	7.1 "					

Ag ARGENTUM

NaCl equation:

Fomin 1953 gives the equation $S = 4.2 \times 10^{-5} M + 5.4 \times 10^{-7}$ for the solubility of AgCl in NaCl solutions at 25°. S = moles AgCl per liter, M = initial moles Cl⁻ per liter.

Results with NaCl(+ NaClO₄)

Leden, 1952 and Berne and Leden, 1953 give data for the solubility of AgCl in solutions containing 0.2 M to 5 M NaCl + NaClO₄ (constant ionic strengths) using a radioactive tracer assay technique.

Cl

Results with RbCl

	moles per liter	
25°	0.035	1.81×10^{-6} (3)

Results with SrCl₂

	moles per liter	
25°	0.0185	0.00172×10^{-3} (3)
	.275	.033 "
	.495	.092 "
	.670	.173 "
	.786	.236 "
	.909	.348 "
	1.070	.510 "
	1.238	.747 "
	1.496	1.252 "
	1.747	2.018 "
	2.076	3.594 "
	2.608	8.174 "
	2.888	12.040 "

Results with ZnCl₂

	wt. %	
24.5°	Saturated	0.0134 (2)
	moles per liter	
25°	2.388	3.64×10^{-4} (1)

SOLUBILITY OF SILVER CHLORIDE IN SOLUTIONS OF VARIOUS NITRATES
(see pp 66-70 for data on chlorides)

- (1) Popoff and Neuman, 1930; Neuman, 1932 { Repeated observation of the formation of a turbidity upon mixing solutions of varying concentrations. Every precaution to insure purity, equilibrium and accuracy was employed.
- (2) Morse, 1902 { HNO_3 was present in all cases. No change in AgCl solubility occurred over the range 0.1 - 2 M HNO_3 . Crystallized and amorphous AgCl gave identical results.
- (3) Brown and MacInnes, 1935 { by potentiometric titration, minimizing liquid junction potential error.
- (4) Dave and Kriahnaswami, 1933
- (5) Mulder, 1864
- (6) Pinkus and Haurez, 1938 { Seventeen determinations using a highly refined potentiometric method. * indicates the solubility of colloidal AgBr . Cl

See also Bedel, 1937 who precipitated AgCl from AgNO_3 and Ag_2SO_4 solutions using various metal chlorides. The solubility was determined by the opalescence of the solutions. Similar determinations were made by Lorenz and Bergheimer, 1924.

concentration of			concentration of				
t°	Salt	AgCl	Ref.	t°	AgCl	Ref.	
<u>Results with Ba(NO₃)₂</u>			<u>Results with KNO₃</u>				
moles per liter			moles per liter				
25°	0.0064 x 10 ⁻³	1.280 x 10 ⁻⁵	(1)	9.931 x 10 ⁻³	1.427 x 10 ⁻⁵	(1)	
	0.03615 "	1.291 "			13.695 "		1.453 "
	0.2111 "	1.309 "			16.431 "		1.469 "
	0.7064 "	1.339 "			20.064 "		1.488 "
	1.499 "	1.372 "			27.376 "	1.516 "	(3)
	2.192 "	1.394 "			28.6 "	1.569 "	
	3.083 "	1.421 "			33.760 "	1.537 "	(1)
	4.402 "	1.450 "			40.144 "	1.552 "	
	5.600 "	1.467 "			0.1 "	1.58 "	(6)
	8.396 "	1.503 "			0.1 "	1.60-1.65 " *	
	11.193 "	1.526 "		30°	0.10 "	2.93 "	
	13.989 "	1.542 "			0.50 "	5.15 "	
<u>Results with Hg(NO₃)₂</u> (+ 0.1 - 2M HNO ₃)				0.75 "	5.92 "	(4)	
moles per liter				1.00 "	6.93 "		
25°	0.0100	0.00432	(2)	40°	0.1 "		4.30 "
	.0125	.00499		50°	0.1 "		6.05 "
	.025	.00690		<u>Results with La(NO₃)₃</u>			
	.050	.00914		moles per liter			
	.100	.01395		25°	0.00427 x 10 ⁻³	1.280 x 10 ⁻⁵	(1)
	1.000	.04810			0.07626 "	1.305 "	
<u>Results with KNO₃</u>				0.1438 "	1.317 "		
moles per liter				0.5760 "	1.367 "		
0°	0.1	0.79 x 10 ⁻⁵	(4)		1.155 "	1.404 "	
8°	0.1	0.84 "			1.660 "	1.432 "	
18°	0.1	1.42 "			2.807 "	1.477 "	
25°	0.0128 x 10 ⁻³	1.280 "			3.826 "	1.505 "	
	0.2609 "	1.301 "	(1)		5.100 "	1.538 "	
	0.509 "	1.311 "			6.629 "	1.563 "	
	1.005 "	1.325 "					
	4.972 "	1.385 "					

Ag ARGENTUM

SOLUBILITY OF SILVER CHLORIDE IN SOLUTIONS OF VARIOUS NITRATES--Cont.

concentration of			Ref.	concentration of			Ref.
t°	Salt	AgCl		t°	Salt	AgCl	
<u>Results with NH₄NO₃</u>				<u>Results with NaNO₃</u>			
Cl	moles per liter		(4)	18°	wt. %		(5)
	0°	0.10 0.68 x 10 ⁻⁵		0.781 0.00146			
	8°	0.10 0.82 "		moles per liter		(1)	
	18°	0.10 1.44 "		25°	0.01281 x 10 ⁻³ 1.281 x 10 ⁻⁵		
	25°	0.10 3.25 "		0.2643 " 1.300 "			
		0.50 5.23 "		0.5157 " 1.315 "			
		0.75 6.33 "		5.039 " 1.384 "			
		1.00 7.40 "		0.01076 " 1.428 "			
	30°	0.10 3.28 "		0.05 7.35 "	(4)		
	40°	0.10 4.84 "		0.10 10.1 "			
	50°	0.10 6.75 "		0.50 13.5 "			
<u>Results with NaNO₃</u>			0.75 15.5 "				
moles per liter		1.0 17.1 "					
0°	0.10 1.35 x 10 ⁻⁵	3.0 17.5 "					
wt. %		Sat. 18.4 "					
5°	0.781 0.00086	30°	0.0001 1.69 "				
moles per liter		0.001 1.91 "					
8°	0.10 3.00 x 10 ⁻⁵	0.01 2.80 "					
18°	0.10 4.94 "	0.10 10.1 "					
		40°	0.10 10.2 "				
		50°	0.10 10.8 "				

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF SULFATES (Popoff and Neuman, 1930; Neuman, 1932)

[Repeated observation of the formation of a turbidity upon mixing solutions of varying concentrations. Every precaution to insure purity, equilibrium, and accuracy was employed.]

t°	concentration of		t°	concentration of	
	Salt	AgCl		Salt	AgCl
<u>Results with CaSO_4</u>			<u>Results with K_2SO_4</u>		
	moles per liter			moles per liter	
25°	0.0064×10^{-3}	1.281×10^{-5}	25°	0.0064×10^{-3}	1.281×10^{-5}
	0.0317 "	1.287 "		0.0364 "	1.291 "
	0.1075 "	1.306 "		0.2065 "	1.314 "
	0.5119 "	1.344 "		0.7067 "	1.336 "
	1.017 "	1.372 "		1.507 "	1.364 "
	1.522 "	1.395 "		2.207 "	1.386 "
	2.532 "	1.436 "		3.107 "	1.413 "
	3.037 "	1.467 "		4.807 "	1.475 "
				6.511 "	1.503 "
				8.593 "	1.526 "
				10.674 "	1.550 "
				13.276 "	1.576 "

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF SULFATES--Cont.

t°	concentration of		t°	concentration of	
	Salt	AgCl		Salt	AgCl
	Results with $\text{La}_2(\text{SO}_4)_3$			Results with MgSO_4	
	moles per liter			moles per liter	
25°	0.00214×10^{-3}	1.282×10^{-3}	25°	0.00638×10^{-3}	1.276×10^{-3}
	0.00660	1.292		0.031144	1.286
	0.0244	1.309		0.1065	1.301
	0.1033	1.338		0.2206	1.319
	0.2467	1.362		0.5067	1.340
	0.4132	1.387		1.0069	1.377
	0.6690	1.426		1.5072	1.402
	0.9585	1.475		2.5072	1.438
	1.2950	1.512		3.0073	1.454
	1.9048	1.562		5.207	1.489
	2.2853	1.575		7.608	1.525
	2.6655	1.598		10.008	1.544

Cl

SOLUBILITY OF SILVER CHLORIDE IN SOLUTIONS OF VARIOUS SALTS

- (1) Valenta, 1894.
- (2) Cohn, 1895. (Says Valenta used excess AgCl and hence formed less soluble "di-salt" of thiosulfate.)
- (3) Luther and Leubner, 1912.
- (4) Richards and Faber, 1899.
- (5) DuBois, 1949. (Data also given in Na glycinate solutions containing varying amounts of KCl.)

t°	concentration of		Ref.	t°	concentration of		Ref.
	Salt	AgCl			Salt	AgCl	
	Results with KCN				Results with $(\text{NH}_4)_2\text{S}_2\text{O}_3$		
	wt. %				wt. %		
25°	4.87	2.68	(1)		4.93	1.30	(1)
	4.53	4.77	(2)		4.85	2.98	(2)
	Results with $(\text{NH}_4)_2\text{CO}_3$				9.62	3.77	(1)
	wt. %				9.48	5.53	(2)
25°	9.09	0.05	(1)		Results with Na_2SO_3		
	Results with $(\text{NH}_4)_2\text{S}_2\text{O}_3$			25°	wt. %		
	wt. %				9.09	0.44	(1)
20°	0.99	0.57	(1)		16.5	0.94	(1)
	0.99	0.64	(2)				

Ag ARGENTUM

SOLUBILITY OF SILVER CHLORIDE IN SOLUTIONS OF VARIOUS SALTS--Cont.

concentration of				concentration of			
t°	Salt	AgCl	Ref	t°	Salt	AgCl	Ref.
<u>Results with Na₂SO₃</u> <u>(+ .05M excess Cl⁻)</u>				<u>Results with Na₂S₂O₃</u>			
	moles per liter				wt. %		
25°	0.080	0.911			8.72	3.94	(1)
	0.106	0.017			8.78	3.38	(2)
	0.220	0.033			12.36	5.21	(1)
	0.234	0.036			12.42	4.77	(2)
	0.478	0.057			15.70	5.75	(1)
	0.483	0.059	(3)		15.66	6.03	(2)
	0.470	0.070		35°	15.37	8.32	(4)
	0.652	0.103					
	0.890	0.140					
	0.937	0.142					
<u>Results with Na₂S₂O₃</u>				<u>Results with Na Glycinate</u>			
	wt. %				moles per liter		
20°	0.99	0.40	(1)	30°	0.05	0.001855	
	0.99	0.38	(2)		.10	.0038	
	4.67	1.95	(1)		.25	.0100	(5)
	4.68	1.79	(2)		.33	.0135	
					.50	.0199	

Results with Thiocyanates

Data for the solubility(?) of AgCl in aluminum, barium, calcium, potassium, sodium and ammonium thiocyanate solutions is given by Valenta, 1894.

SOLUBILITY OF SILVER CHLORIDE IN UREA AND GLYCINE SOLUTIONS AT 25° (Dunning and Shutt, 1938)

Determined by electrometric titration.

Gms. Urea per 1000 cc. sol.	Gms. AgCl per 1000 cc. sol.	Gms. Glycine per 1000 cc. sol.	Gms. AgCl per 1000 cc. sol.
0.0	0.00242	0.0	0.00238
63.0	.00331	7.5	.00304
126.1	.00411	15.0	.00333
147.1	.00436	22.5	.00378
180.2	.00456	37.5	.00440
210.2	.00513	52.5	.00476
315.3	.00639	75.1	.00563
427.9	.00753	90.1	.00586
		112.6	.00654

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF THIOUREA
(THIOCARBAMIDE) AND THIOCYANIMINE AT 25°
(Valenta, 1894)

gms. per 100 gms. sat. sol.		gms. per 100 gms. sat. sol.	
Thiocarbamide	AgCl	Thiocyanime	AgCl
9.02	0.82	0.99	0.40
		4.67	1.86
		8.75	3.75

SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS METHANOL SOLUTIONS Cl
(Parton, Davis, Hurst and Gemmell, 1945; Parton and Perrin, 1945)

t°	wt. % methanol							
	10%		50%		50%		75%	
	moles x 10 ⁵		moles x 10 ⁵		moles x 10 ⁵		moles x 10 ⁵	
	AgI per		AgI per		AgI per		AgI per	
	1000		1000		1000		1000	
	gms.	liter	gms.	liter	gms.	liter	gms.	liter
	Sol-	Sat.	Sol-	Sat.	Sol-	Sat.	Sol-	Sat.
	vent	Sol.	vent	Sol.	vent	Sol.	vent	Sol.
15	0.604	0.593	0.475	0.460	0.182	0.167	0.0702	0.0606
20	0.770	0.756	0.599	0.579	0.243	0.223	0.0870	0.0747
25	0.970	0.951	0.752	0.725	0.279	0.273	0.1072	0.0916
30	1.217	1.191	0.953	0.917	0.373	0.338	0.1315	0.1119
35	1.502	1.467	1.180	1.133	0.459	0.413	0.1611	0.1365
40	1.849	1.801	1.452	1.390	0.558	0.500	0.1963	0.1654
45	2.250	2.187	1.778	1.716	0.680	0.605	0.2388	0.2000

SOLUBILITY OF AgCl IN HCl SOLUTIONS IN AQUEOUS METHANOL,
ETHANOL, AND ACETONE AT 20°
(Kratohvil and Tezak, 1954)

HCl was added to AgNO₃ solutions until the turbidity of AgCl just disappeared. The solution therefore also contained HNO₃ equal to the amount of AgNO₃ dissolved. The dielectric constant D of each solvent is listed. Concentrations are given in moles per liter, solvents in weight percent.

Ag ARGENTUM

moles AgCl per liter	moles HCl per liter			
	methanol	ethanol	Acetone	
	62% D = 50.4	50% 50.4	48.5% 50.4	82% 29.0
0.001	2.175	.....	1.65	0.27
.0004	1.35	1.425	0.85	0.088
.0001	0.58	0.575	0.25	0.0155
.00004	0.325	0.29	0.095	0.00525
.00002	.....	.....	.....	0.0023
.00001	0.095	0.085	0.022	0.00095
Cl .000004	0.042	.....	0.007	0.000325
.000001	0.0058	.....	0.000095	0.000055

SOLUBILITY OF SILVER CHLORIDE IN ABSOLUTE METHYL AND ETHYL ALCOHOLS AT 25° (Neustadt, 1910; Koch, 1930; Buckley and Hartley, 1939)

From conductivity and E.M.F. measurements the ratios of the solubilities of silver chloride in water and alcohols were calculated. By means of these figures and previously determined results for the solubility of silver chloride in water the following estimates were made:

Solvent	Mols. AgCl per liter	Gm. AgCl per liter
(Water)	(1.3×10^{-5})	(0.001863) (K.)
CH ₃ OH	3.9×10^{-7}	0.0000559 (K.)
	2.35×10^{-7}	0.0000337 (B.&H.)
	4.5×10^{-7}	0.000065 (N.) (20°-23°)
C ₂ H ₅ OH	9.6×10^{-8}	0.0000138 (K.)
	1.3×10^{-7}	0.000019 (N.) (20°-23°)

SOLUBILITY OF SILVER CHLORIDE IN PYRIDINE (Kahlenberg and Wittich, 1909)

t°	Gms. AgCl per 100 Gms. Pyridine	Solid Phase	t°	Gms. AgCl per 100 Gms. Pyridine	Solid Phase
-57 Eutec.	....	AgCl·2C ₅ H ₅ N + C ₆ H ₅ N	0	5.35	AgCl
-49	0.77	AgCl·2C ₅ H ₅ N	10	3.17	"
-35	0.99	"	20	1.91	"
-30	1.36	"	30	1.20	"
-25	1.80	"	40	0.80	"
-22	2.20	"	50	0.53	"
- tr. pt.	2.75	" + AgCl·C ₅ H ₅ N	60	0.403	"
-20	3.75	AgCl·C ₅ H ₅ N	70	0.32	"
-18	3.85	"	80	0.25	"
-10	4.35	"	90	0.22	"
- 5	5.05	"	100	0.18	"
- 1	5.60	"	110	0.12	"

SOLUBILITY OF SILVER CHLORIDE IN PYRIDINE SOLUTIONS
OF BERYLLIUM CHLORIDE AT 15°
(Schmidt, 1929)

Gms. per liter of C ₅ H ₅ N Solution		Gm. mola. per liter of C ₅ H ₅ N sol.		Solid Phase
BeCl ₂	AgCl	BeCl ₂	AgCl	
7.99	44.2	0.10	0.308	AgCl
15.98	62.7	0.20	0.438	"
23.98	97.7	0.30	0.682	"
31.97	141.1	0.40	0.985	"
39.97	179.7	0.50	1.254	"
47.96	211.7	0.60	1.477	"
55.96	246.7	0.70	1.722	"
63.95	287.7	0.80	2.008	"
71.95	322.0	0.92	2.247	"
79.94	356.0	1.00	2.484	"
102.32	449.2	1.28	3.130	"

The solubility of silver chloride in diethyl ether containing 1 M LiClO₄ is 7×10^{-8} moles per liter at 23.5°. (Althin, Wahlin, and Sillen, 1949.)

SOLUBILITY OF SILVER CHLORIDE IN LIQUID AMMONIA AND SULFUR DIOXIDE

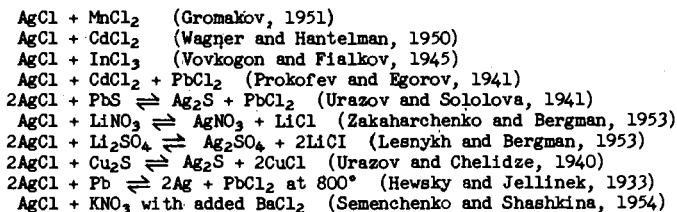
t°	Gms. AgCl per 100 gms. NH ₃
-33.9 (d sat. sol. = 0.684)	0.215 (Johnson and Krumbolts, 1933)
0	0.28 (Linhard and Stephan, 1933, 1934)
25.0	0.83 (Hunt and Boneyk, 1933)

Gms. AgCl per 100 gms. SO ₂
0 less than 0.01 (Jander and Wickert, 1936; Jander and Ruppolt, 1937)

Fusion point data are given for the following mixtures:

AgCl + Ag ₂ SO ₄	(Sokolov, 1930)
AgCl + AgNO ₃	(Lifshitz, 1955)
AgCl + AgI	(Mönkemeyer, 1906; Bergmann and Gönke, 1926; Raynaud, Duranté, Hervier, and Pouradier, 1955)
AgCl + Ag ₂ S	(Truthe, 1912; Sandonnini, 1912)
AgCl + BeCl ₂	(Schmidt, 1929)
AgCl + CsCl	(Sandonnini and Scarpa, 1912; Sandonnini, 1914)
AgCl + Hg ₂ Cl ₂	(Jänecke, 1923)
AgCl + HgCl ₂	(Bergmann and Gönke, 1926)
AgCl + KI	(Rostkowski, 1929 (2))
AgCl + LiCl	(Sandonnini, 1911 (a); 1914)
AgCl + MgCl ₂	(Menge, 1911)
AgCl + NH ₄ Cl	(Jänecke, 1923)
AgCl + NaCl	(Botta, 1911; Sackur, 1913; Sandonnini, 1911, 1914; Zemeznznz, 1926)
AgCl + PbCl ₂	(Matthes, 1911; Tries, 1914; Pelabon and Lande, 1928)
AgCl + TlCl	(Sandonnini, 1911, 1914; Biltz and Friedrich, 1924)

Ag ARGENTUM



SILVER CHLORIDE - THIOUREA SALTS

SOLUBILITY OF EACH IN WATER

Silver Chloride .3 Thiourea " " .5 "			Silver Chloride Thiosinamine (allyl thio carbamide)		
(Walter, Adler and Reimer, 1934)			(Sheppard and Hudson, 1927)		
t°	Formula	Gms. Compd. per liter	t°	Formula	Gms. Compd. per liter
15-20	$\text{AgCl} \cdot 3(\text{NH}_2 \cdot \text{CS} \cdot \text{NH}_2)$	23.70	15	$\text{AgCl} \cdot \text{NH}_2 \text{CSNHC}_3\text{H}_5$	0.0517
15-20	$\text{AgCl} \cdot 5(\text{NH}_2 \cdot \text{CS} \cdot \text{NH}_2)$	786.34	25	"	0.0816
			35	"	0.1313
			50	"	0.4578

ClO SILVER CHLORITE AgClO_2

SOLUBILITY OF SILVER CHLORITE IN WATER (Levi, 1923)

t°	Gms. AgClO_2 per 100 gms. sat. sol.	t°	Gms. AgClO_2 per 100 gms. sat. sol.
0	0.17	50	0.88
18	0.44	75	1.40
35	0.60	100	2.11

ClO SILVER CHLORATE AgClO_3

SOLUBILITY OF SILVER CHLORATE IN H_2O AND $\text{H}_2\text{O} - \text{D}_2\text{O}$ MIXTURES (Noonan, 1948; Ricci and Offenbach, 1951)

Temp.	Gms. AgClO_3 per 100 gms. sat. sol. in H_2O	Gms. AgClO_3 per 100 gms. sat. sol. in $\text{H}_2\text{O} + \text{D}_2\text{O}$
5°	7.847	5.884 (98.38% D_2O)
15°	10.868	8.388 (98.38% D_2O)
25°	15.281	11.501 (98.38% D_2O)
	14.46 (R.&O.)	...
35°	19.185	15.444 (98.18% D_2O)

THE SYSTEM SILVER CHLORATE - SODIUM CHLORATE - WATER AT 25°
(Ricci and Offenbach, 1951)

Solid solutions of Roozeboom type five were found.

Sat'd. sol. wt. %		Density	wt. % AgClO_3	Solid Phase
AgClO_3	NaClO_3		in Solid Phase	
14.46	0.0	1.126	100	AgClO_3
10.02	8.11	1.143	99.1	Solid Solution I
7.48	17.49	1.194	95.7	"
5.56	27.53	1.270	86.9	"
4.23	34.39	1.317	77.4	"
2.85	41.78	1.375	70.1	"
2.15	46.55	1.415	....	S.S. I + S.S. II
1.66	47.52	1.419	22.5	Solid Solution II
0.56	49.23	1.428	9.9	"
0.0	50.04	1.424	0	NaClO_3

SILVER PERCHLORATE AgClO_4

ClO

SOLUBILITY OF SILVER PERCHLORATE IN WATER
(Hill, 1922; Smith and Ring, 1937)

t°	d of sat. sol.	Gms. AgClO_4 per 100 gms. sat. sol.	Solid Phase
- 0.16 .....	.....	0.96	Ice
- 3.0 .....	.....	26.55	"
-10.0 .....	.....	45.2	"
-24.0 .....	.....	60.3	"
-40.0 .....	.....	70.4	"
-58.2 Eutec.	2.315	73.9	" + $\text{AgClO}_4 \cdot \text{H}_2\text{O}$
0	2.667	81.3	$\text{AgClO}_4 \cdot \text{H}_2\text{O}$
	2.7251	82.07(S.&R.)	"
10	2.7594	82.88(S.&R.)	"
20	2.8163	84.04(S.&R.)	"
25	2.8487	84.78(S.&R.)	"
	2.806	84.5	"
30	2.8825	85.59(S.&R.)	"
35	2.9173	86.21(S.&R.)	"
43 .....	.....	86.5	" + AgClO_4
50	2.995	87.2	$\text{AgClO}_4 \cdot \text{H}_2\text{O}^*$
75	3.022	88.1	AgClO_4
99	3.069	88.8	"

*metastable

Ag ARGENTUM

SOLUBILITY OF SILVER PERCHLORATE IN AQUEOUS SOLUTIONS OF PERCHLORIC ACID (Smith and Ring, 1937)

d ₀ sat. solu- tion	Results at 0°		d ₂₅ of sat. sol.	Results at 25°	
	Gms. HClO ₄ per 100 gms. solvent	Gms. AgClO ₄ per 1000 gms. sat. sol.		Gms. HClO ₄ per 100 gms. solvent	Gms. AgClO ₄ per 100 gms. sat. sol.
1.7520	60.16	17.41	1.7790	60.00	21.611
1.6987	64.31	7.031	1.7066	64.08	11.765
1.7107	68.08	4.151	1.6993	68.02	6.080
1.7575	73.60	2.136	1.7436	73.60	3.011

C10

THE SYSTEM SILVER PERCHLORATE - BENZENE - WATER AT 25° (Hill, 1921, 1922, 1923)

[SOLUBILITY OF AgClO₄ IN BENZENE - WATER SOLUTIONS]

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	AgClO ₄	C ₆ H ₆	
2.806	84.45	0.0	AgClO ₄ ·H ₂ O
2.823	84.28	1.19	"
...	84.1	1.7	" + AgClO ₄ ·C ₆ H ₆
2.806	83.98	1.68	AgClO ₄ ·C ₆ H ₆
2.808	83.93	1.36	"
2.747	83.12	1.55	"
2.644	81.39	1.41	"
...	75.53	7.75	"
2.103	69.27	15.81	"
1.978	65.69	22.32	"
1.851	62.01	28.14	"
1.562	51.89	43.18	"
1.462	46.80	50.34	"
1.358	42.57	55.53	"
1.254	35.20	63.52	"
1.200	31.92	67.03	"
1.197	31.45	67.54	"
1.123	25.40	73.90	"
1.021	15.37	84.29	"
1.000	13.90	85.82	"

d of sat. sol.	Gms. per 100 gms. sat. sol.			Solid Phase
	AgClO ₄	C ₆ H ₆	H ₂ O	
...	10.65	89.13	...	AgClO ₄ ·C ₆ H ₆
0.960	10.45	89.34	...	"
...	9.938	89.876	0.1864	"
0.949	9.55	90.26	...	"
...	9.455	90.376	0.1691	"
...	9.316	90.520	0.1641	"
0.947	9.01	90.84	...	"
...	8.928	90.922	0.1500	"
...	8.351	91.520	0.1290	"
0.9367	8.28	91.60	...	"
...	7.639	92.259	0.1025	"
0.9332	7.31	92.58	...	"
...	6.892	93.034	0.0743	"
0.9259	6.84	93.08	...	"
...	6.267	93.682	0.0513	"
0.9221	6.18	93.77	...	"
0.9205	5.96	94.00	...	"
...	5.900	94.064	0.0361	"
0.906	4.981	95.019	0.0000	"

ClO

[DATA ON THE BINODAL CURVE]

Data on the Binodal curve.

The components were weighed into a small cylinder and rotated at 25° until equilibrium was established. Samples of each layer were titrated for their silver content. The benzene and water were determined indirectly. For this purpose a weighed amount of each solution was treated with an excess of anhydrous silver perchlorate and agitated at 25° until equilibrium was reached. The silver perchlorate now present in the solution was determined by titration and the point corresponding to this composition on the 25° solubility curve (see above) was taken as giving the relative proportions of water and benzene present. The volumes of both phases in the original experiment were read in the calibrated cylinder, so that the water and benzene content of the phase L₃ was known by subtraction of the composition of L₁ from the known total composition.

Composition of Conjugated Solutions

	Lower layer L ₂ Gms. per 100 gms. mixture			d ₂₅	Upper layer L ₁ Gms. per 100 gms. mixture		
	AgClO ₄	C ₆ H ₆	H ₂ O		AgClO ₄	C ₆ H ₆	H ₂ O
...	0.00	0.08	99.92	...	0.00	99.95	0.061
1.628	50.81	0.10	49.09	0.869	0.030	99.91	0.06
1.821	59.30	1.00	39.70	0.870	0.052	99.89	0.06
2.050	67.73	1.96	30.31	0.873	0.25	99.69	0.06
2.127	70.52	3.76	25.72	0.879	0.77	99.17	0.06
2.071	69.31	11.17	19.51	0.881	1.55	98.37	0.076
C10 1.749	60.06	26.15	13.78	0.881	1.59	98.32	0.090
1.653	57.88	30.74	11.38	0.882	1.74	...	...
1.566	54.22	36.36	9.42	0.882	1.85	...	...
1.442	46.95	47.57	5.47	0.891	2.90	97.00	0.0969
1.348	41.74	55.00	3.26	0.903	4.28	95.61	0.119
1.296	38.80	58.62	2.57	0.916	5.80	94.05	0.148
1.218	35.28	63.23	1.49	0.937	8.42	91.41	0.168
1.200	31.92	67.03	1.04	0.960	10.42	89.34	0.21
1.162	31.12	68.06	0.82	0.983	13.58	86.13	0.287

Data are also given for the composition of the ternary solutions of the invariant (Quintuple points) and monovariant equilibrium from $-58^{\circ}.4$ to 145° , and selected isotherms in this range of temperatures are shown schematically by means of triangular diagrams.

EQUILIBRIUM IN THE SYSTEM SILVER PERCHLORATE, TOLUENE AND WATER AT 25°
(Hill and Miller, Jr., 1925)

Results for solutions in contact with:

d. of sat. sol.	AgClO ₄ Gms. per 100 gms. sat. sol.			d. of sat. sol.	AgClO ₄ ·H ₂ O Gms. per 100 gms. sat. sol.		
	AgClO ₄	C ₆ H ₅ ·CH ₃	H ₂ O		AgClO ₄	C ₆ H ₅ CH ₃	H ₂ O
1.525	50.30	49.70	0.0	1.675	56.66	41.51	1.92
1.580	52.54	46.86	0.60	...	56.95	40.07	2.86
1.606	53.49	45.49	1.02	1.696	57.44	38.96	3.67
1.628	54.75	43.84	1.41	1.702	57.56	38.72	3.86
1.639	54.92	43.66	1.42	1.710	57.96	37.98	4.12
1.672	56.65	41.46	1.89	1.709	58.11	37.72	4.16
1.675	56.66	41.42	1.92	1.715	58.34	37.32	4.19

The authors made a complete investigation of the ternary system and found seven invariant 5-phase points and twenty 4-phase equilibria between the temperatures -94° and $+91^{\circ}.75$. The numerical data for these are given. The system shows, in addition to the solubility curves for the three solid phases (silver perchlorate, its hydrate and its compound with toluene), two binodal curves, one of which is submerged and does not reach any of the two component axes at any temperature. The intersection of the two binodal curves, at certain points which are not their plait points, gives rise to a 3-liquid system which is stable from $-24^{\circ}.1$ to above $+90^{\circ}$.

Results for the conjugate Solutions. (Showing mutual Solubility of Toluene and Water as affected by the presence of Silver perchlorate.)

d_{25}	Upper layer L ₁ Gms. per 100 gms. mixture			d_{25}	Lower Layer L ₂ Gms. per 100 gms. mixture		
	AgClO ₄	C ₆ H ₅ CH ₃	H ₂ O		AgClO ₄	C ₆ H ₅ CH ₃	H ₂ O
0.854	0.0	100.0	0.0	1.344	33.34	0.0	66.64
0.850	0.0	100.0	0.0	1.436	39.37	0.0	60.03
0.852	0.0	100.0	0.0	1.730	55.21	1.59	43.20
0.914	7.37	92.48	0.19	2.360	75.57	2.1	22.33
1.307	39.35	56.93	3.70	2.360	75.57	2.1	22.33
1.372	43.44	52.01	4.55	2.389	76.09	2.2	21.71
1.442	45.88	49.65	4.77	2.421	76.28	2.25	21.47
1.491	49.07	45.98	4.95	2.480	78.00	2.4	20.6
1.574	54.08	40.47	5.45	...	80.64	2.45	16.91
1.715	58.34	37.32	4.34	2.830	84.29	2.52	13.19

The following results were obtained for the submerged binodal curve at 25°:

0.914	7.37	92.48	0.19	1.307	39.35	56.95	3.70
0.930	8.97	91.73	0.30	1.261	36.26	60.69	3.05
0.951	11.00	88.64	0.36	1.210	32.18	65.54	2.28
1.005	16.04	83.17	0.79	...	26.67	71.73	1.60
...	21.0	77.9	1.1	...	21.00	77.9	1.1

EQUILIBRIUM IN THE SYSTEM SILVER PERCHLORATE, ANILINE AND WATER AT 25°
(Hill and Macy, 1924)

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	AgClO ₄	C ₆ H ₅ NH ₂			AgClO ₄	C ₆ H ₅ NH ₂	
1.063	5.00	95.00	1.6	1.066	8.32	trace	1.3 + 1.2
...	7.18	91.56	"	1.086	10.7	"	1.2
...	8.00	90.00	"	...	21.39	"	"
1.096	8.48	88.92	"	1.294	28.55	"	"
1.106	9.42	86.34	"	...	53.71	"	"
1.001	trace	4.57	"	...	57.13	"	" + 1.1
...	"	trace	" + 1.3	1.859	60.02	"	1.1
1.007	1.02	"	1.3	...	70.00	"	"
1.018	2.53	"	"	2.634	81.3	"	"
...	5.94	"	"	"	84.22	"	" + AgClO ₄ ·H ₂ O
1.059	7.03	"	"	2.806	84.5	0.0	AgClO ₄ ·H ₂ O

1.6 = AgClO₄·6C₆H₅NH₂; 1.3 = AgClO₄·3C₆H₅NH₂; 1.2 = AgClO₄·2C₆H₅NH₂;
1.1 = AgClO₄·C₆H₅NH₂.

Ag ARGENTUM

The following results are given for the distribution (Binodal) curve.

Aqueous Phase			Aniline Phase		
% AgClO_4	% $\text{C}_6\text{H}_5\text{NH}_2$	% H_2O	% AgClO_4	% $\text{C}_6\text{H}_5\text{NH}_2$	% H_2O
0.0	3.66	96.34	0.0	94.78	5.22
...	....	.....	2.70	92.48	4.82
...	....	.....	6.29	89.40	4.31
trace	5.57	95.43	9.42	86.34	4.24

Data are then given for the composition of the ternary solutions in the invariant and monovariant equilibria at -58.8° to $+66^\circ$, and selected isotherms in this range of temperatures are shown schematically by means of triangular diagrams.

EQUILIBRIUM IN THE SYSTEM SILVER PERCHLORATE, PYRIDINE AND WATER AT 25° (Macy, 1925)

Constant agitation was employed for obtaining saturation. Highly purified materials were used.

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	AgClO_4	$\text{C}_5\text{H}_5\text{N}$			AgClO_4	$\text{C}_5\text{H}_5\text{N}$	
1.201	20.9	79.1	1.4	...	10.76	0.0	4.9
1.185	19.5	69.9	"	1.156	17.0	0.0	"
1.170	17.8	65.9	"	...	17.4	0.0	"
1.135	14.5	60.0	"	1.186	20.0	0.0	" + 1.2
1.093	9.8	51.0	"	...	20.2	0.0	1.2
1.060	6.6	42.4	"	...	35.6	0.0	"
1.014	1.3	20.6	"	...	54.6	0.0	"
1.005	0.48	5.38	"	...	77.0	0.0	"
1.002	0.40	3.8	" + 4.9	...	84.3	0.0	" + $\text{AgClO}_4 \cdot \text{H}_2\text{O}$
1.065	7.0	trace	4.9	2.806	84.5	0.0	$\text{AgClO}_4 \cdot \text{H}_2\text{O}$

SOLUBILITY OF SILVER PERCHLORATE IN ORGANIC SOLVENTS

t°	Gms. AgClO ₄ per 100 gms. sat. sol.	density sat. sol.	Solid Phase
IN BENZENE (Hill, 1922, 1923(*); S. = Spurgeon, 1941)			
5.48	0.00	....	C ₆ H ₆
5.12	3.44	0.909	C ₆ H ₆ + AgClO ₄ ·C ₆ H ₆
25.0	5.00	0.906	AgClO ₄ ·C ₆ H ₆ C10
	(4.98)*		
	5.69(S.)	0.9139(S.)	"
50.0	10.7	0.896	"
80.3	32.2	1.164	"
92.0	40.1	....	"
115.5	50.5	....	"
138.5	60.0	....	"
140.0	62.6	....	AgClO ₄ (metastable)
145.0	63.0	....	AgClO ₄ ·C ₆ H ₆ + AgClO ₄
159.0	64.6	....	AgClO ₄
160	65.6	....	"
IN TOLUENE (Hill and Miller, Jr. 1925)			
- 75.3	0.0	0.854	AgClO ₄ ·C ₇ H ₈
- 24.1	6.01	0.920	"
0.	26.41	1.129	"
16.	42.0	1.375	"
16.5	42.89	1.388	"
18	44.11	1.417	AgClO ₄ ·C ₇ H ₈
22.6 tr.pt.	...	....	" + AgClO ₄
25	50.30	1.523	AgClO ₄
50	52.68	1.576	"
75	54.60	1.665	"
IN ANILINE (Hill and Macy, 1924)			
- 6.15 m.pt.	0.00	....	C ₆ H ₅ NH ₂
- 6.6	0.74	1.030	C ₆ H ₅ NH ₂ + AgClO ₄ ·6C ₆ H ₅ NH ₂
+ 25.0	5.0	1.063	AgClO ₄ ·6C ₆ H ₅ NH ₂
40.0	11.4	....	"
50.1	17.0	....	"
60.52 m.pt.	27.06	....	"
55.0	30.9	1.281	"
48.3	33.0	....	1.6 + AgClO ₄ ·3C ₆ H ₅ NH ₂
58.1	35.0	1.101	1.3
66.6	38.4	....	1.3 + AgClO ₄ ·2C ₆ H ₅ NH ₂
88.0	40.0	....	1.2
483. m.pt.	100.0	....	AgClO ₄

Ag ARGENTUM

	Gms. AgClO ₄ per 100 gms. sat. sol.	density sat. sol.	Solid Phase
IN CHLOROBENZENE (Spurgeon, 1941)			
25	0.0207	1.104	
IN NITROBENZENE (Spurgeon, 1941)			
C10 25	0.767	1.197	
IN CYCLOHEXANE (Spurgeon, 1941)			
25	0.001	0.7722	
IN PYRIDINE (Macy, 1925)			
At the lower temperatures a Beckmann freezing point apparatus was			
A few determinations made with Kahlbaum's pyridine gave results a			
1.5% higher than the above, due possibly to the presence of homol			
of pyridine.			
- 40.3 m.pt.	0.0	....	C ₆ H ₅ N
- 41.5	4.0	....	"
- 43.0	7.2	....	C ₆ H ₅ N + AgClO ₄ ·4C ₆ H ₅ N
- 35.0	8.3	....	1.4
- 11.5	12.23	1.118	"
- 1.3	14.53	1.139	"
+ 25.0	20.00	1.201	"
36.1	24.52	1.221	"
49.2	29.4	1.278	"
60.4	34.5	....	"
66.8	41.1	....	"
68.0	41.7	....	1.4 + 4AgClO ₄ ·9C ₆ H ₅ N
71.0	42.4	....	4.9
75.0	43.0	....	"
86.3	45.8	....	"
95.6	47.8	....	4.9 + AgClO ₄ ·2C ₆ H ₅ N
110.	50.0	....	1.2
144-147	.....	....	1.2 + AgClO ₄
IN FURFURAL (Chaney and Mann, 1931)			
about 20°	28.6	....	...
IN CELLOSOLVE (mono ethyl ether of ethylene glycol) (Chaney and Mann, 1931)			
about 20°	55.6	....	...
IN m-XYLENE (Spurgeon, 1941)			
5.5	3.21	....	...
15.6	7.31	....	...
25.0	12.58	1.006	...
30.0	20.7	....	...
37.7	45.3	....	...

Data for the lowering of the freezing-point, especially the eutectic temperature, of mixtures of acetic acid and benzene by the addition of AgClO_4 are given by Anders, 1933.

SILVER ANTIPYRINE PERCHLORATE $[\text{Ag}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_3]\text{ClO}_4$

ClO

100 gms. of a saturated solution in water contains 10.94 gms. of the salt at 20° . (Wilke-Dörfurt and Schliephake, 1929)

SILVER CHROMATE Ag_2CrO_4

CrO

SILVER DICHROMATE $\text{Ag}_2\text{Cr}_2\text{O}_7$

SOLUBILITY OF SILVER CHROMATE IN WATER

Gms. Ag_2CrO_4 per liter t° sat. sol.			Gms. Ag_2CrO_4 per liter t° sat. sol.		
0.26	0.0142	(Kohlrausch, 1908)	27	0.0341	(Whitby, 1910)
14.8	0.0225	(")	30.7	0.0362	(Kohlrausch, 1908)
18	0.026	(Abegg and Cox, 1903)	50	0.0534	(Whitby, 1910)
	0.0256	(Whitby, 1910)	75	0.084	(Kohlrausch, 1908)
25	0.020	(Kohlrausch, 1904-05)	100	0.64	(Carpenter, 1886)
	0.029	(Schäfer, 1905)			
	0.0357	(Genchev, 1950-51)			

Murgulescu (1941) found the solubility product of silver chromate t to be 7.1×10^{-13} using a potentiometric method.

SOLUBILITY OF SILVER DICHROMATE IN WATER
(Mayer, 1903)

One liter of aqueous solution contains 0.00019 gm. mol. or 0.083 gm. $\text{Ag}_2\text{Cr}_2\text{O}_7$ at 15° .

EQUILIBRIUM IN THE SYSTEM SILVER OXIDE - CHROMIC OXIDE - WATER
AT 29.9°
(Campbell and Lemaire, 1947)

There are two compounds in the system: Ag_2CrO_4 and $\text{Ag}_2\text{Cr}_2\text{O}_7$, which probably form a pair of solid solutions in each other. The solid solution of Ag_2CrO_4 in $\text{Ag}_2\text{Cr}_2\text{O}_7$ was found to exist up to about 2%, but because of the very small solubility of $\text{Ag}_2\text{Cr}_2\text{O}_4$ in water, the solubility curve for the solid solution of $\text{Ag}_2\text{Cr}_2\text{O}_7$ in Ag_2CrO_4 could not be found. The conductance of each saturated solution was also determined.

Ag ARGENTUM

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Ag ₂ O	CrO ₃	Solid Phase	Ag ₂ O	CrO ₃	Solid Phase
Trace	.....	Ag ₂ O + Ag ₂ CrO ₄	0.1	24.0	Solid Solution
0.10	0.20	Ag ₂ CrO ₄ + Solid sol'n.	.1	35.1	"
.07	0.34	Solid Solution	.1	47.0	"
.08	2.55	"	.1	53.6	"
0.1	4.07	"	.1	58.7	"
.1	7.11	"	.1	62.0	Ag ₂ Cr ₂ O ₇ + CrO ₃
.1	8.11	"	.1	64.9	"
.1	18.4	"			

CrO

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS NITRIC ACID AT 25° (Sherrill and Russ, 1907)

Mols. HNO ₃ per liter	Milliatoms per liter		Solid Phase	Mols. HNO ₃ per liter	Milliatoms per liter		Solid Phase
	Cr	Ag			Cr	Ag	
0.01	3.157	6.315	Ag ₂ CrO ₄	0.06	6.833	...	Ag ₂ CrO ₄
0.015	3.730	...	"	0.07	7.333	...	"
0.02	4.177	8.356	"	0.075	7.477	14.85	" + Ag ₂ Cr ₂ O ₇
0.025	4.567	...	"	0.08	7.260	15.45	"
0.03	5.200	...	"	0.10	5.647	19.01	"
0.04	5.803	11.62	"	0.13	4.293	23.89	"
0.05	6.380	...	"	0.14	3.948	25.63	"

SOLUBILITY OF SILVER DICHROMATE IN AQUEOUS NITRIC ACID AT 25° (Sherrill and Russ, 1907)

Mols. HNO ₃ per liter	Milliatoms per liter		Solid Phase
	Cr	Ag	
0	32.20	5.390	AgCrO ₄ + Ag ₂ Cr ₂ O ₇
0.01	25.06	6.131	" "
0.02	20.21	7.148	" "
0.04	13.59	9.529	" "
0.06	11.10	11.1	Ag ₂ Cr ₂ O ₇
0.08	11.1	11.1	"
0.08 + 0.1 AgNO ₃	6.625	...	"

At the lower concentrations some of the dichromate is converted into solid chromate.

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS AMMONIA AT 25° (Sherrill and Eaton, 1907)

Mols. NH ₄ OH per Liter	0.01	0.02	0.04	0.08
Mols. x 10 ³ Ag ₂ CrO ₄ per Liter	2.004	4.169	8.595	17.58

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS SALT SOLUTIONS AT 20° AND 100°
(Sirucek and Viktorin, 1947 at 20°; Carpenter, 1886 at 100°)

Further data on the increased solubility in solutions of the nitrates, acetates, and sulfates of lithium, sodium, potassium, magnesium, calcium, strontium, ammonium, and aluminum are given by Genchev, 1950-51.

Results at 20°

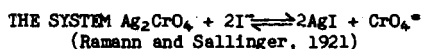
Added Salt		Ag ₂ CrO ₄	
Mols. per liter of Solvent	Gms. per liter of Solvent	Mols. per 1000 gms. Sat. Sol.	Gms. per 1000 gms. CrO Sat. Sol.
KNO₃			
0.0	0.0	0.00009073	0.0301±
0.005	0.51	0.0001028	.0002*
.04	4.04	.00012425	.0342
.1	10.11	.0001445	.0412
.16	16.18	.00015672	.0479
			.0520
NH₄NO₃			
0.005	0.40	0.0001115	0.0370
.025	2.00	.0001443	.0479
.05	4.00	.0001657	.0550
.1	8.01	.0002028	.0673
.16	12.81	.0002293	.0761
NaNO₃			
0.005	0.43	0.0001033	0.0343
.04	3.40	.0001234	.0409
.1	8.50	.0001455	.0483
.16	13.60	.0001562	.0518
Mg(NO₃)₂			
0.005	0.74	0.0001159	0.0385
.01	1.48	.0001266	.0420
.02	2.97	.0001405	.0466
.05	7.42	.0001712	.0568
C₆H₅SO₃Na			
0.02	3.60	0.0001163	0.0386
.1	18.02	.0001386	.0460

*Average of 14 determinations.

Results at 100°

Added salt	Solvent:	gms. AgCrO ₄ per 100 cc sat. soln.
	gms. added salt per 100 ml. H ₂ O	
None	0	0.064
Sodium Nitrate	50	0.064
Potassium Nitrate	50	0.192
Ammonium Nitrate	50	0.320
Magnesium Nitrate	50	0.256

Ag ARGENTUM



Silver nitrate solutions were added to excess of various mixtures of potassium chromate and iodate dissolved in water, and the distribution of silver between CrO_4 and IO_3 determined at various temperatures and after various lengths of time.

SOLUBILITY OF SILVER DICHROMATE IN AQUEOUS ALCOHOL

(Guerini, 1912)

One liter 65% aqueous alcohol dissolves 0.78×10^{-4} gms. equivalents = 0.0129 gm. Ag_2CrO_4 at room temp. (?).

F SILVER FLUORIDE AgF

SOLUBILITY IN WATER

(Jahn-Held and Jellinek, 1936; Guntz and Gunz, Jr., 1914)

t°	Mols. AgF per 1000 gms. H ₂ O	Gms. AgF per 100 gms. sat. sol.	Solid Phase	t°	Mols. AgF per 1000 gms. H ₂ O	Gms. AgF per 100 gms. sat. sol.	Solid Phase
-0.03	0.01	0.13	Ice	25	13.97	64.23	AgF·2H ₂ O
-0.182	0.05	0.63	"	30	14.97	65.53	"
-0.984	0.30	3.67	"	35	16.07	67.10	"
-1.583	0.50	5.97	"	39.5	17.5	68.95	" + AgF
-2.936	1.00	11.26	"	45.0	17.26	68.85	AgF
-5.676	2.00	20.24	"	50.0	17.01	68.35	"
-8.69	3.00	27.57	"	108	16.15	67.2	"
-11.8	4.00	33.70	"	wholly metastable equilibria			
-14.2	4.73	37.51	" + AgF·4H ₂ O				
-10.0	5.24	39.96	AgF·4H ₂ O	0	13.71	63.5	3AgF·5H ₂ O
0	6.76	46.18	"	18	15.04	65.6	"
+10	9.43	54.50	"	21.5	15.96	66.9	"
15	11.33	59.98	"	25	16.50	67.7	"
18.65	13.36	62.89	" + AgF·2H ₂ O	27	16.86	68.2	" + AgF·H ₂ O
18	13.27	62.8	AgF·2H ₂ O*	28.5	16.97	68.3	AgF·H ₂ O
20	13.45	63.23	"	38.2	17.59	69.1	" + AgF

*metastable

SOLUBILITY OF SILVER FLUORIDE IN AQUEOUS SOLUTIONS OF
HYDROFLUORIC ACID AT 0° AND AT 24°
(Guntz and Guntz, Jr., 1914)

Selected data. Additional determinations are given at temperatures from 0° to 108°.

Results at 0°			Results at 14°			Results at 24°		
Gms. per 100 Gms. H ₂ O		Solid Phase	Gms. per 100 Gms. H ₂ O		Solid Phase	Gms. per 100 Gms. H ₂ O		Solid Phase
AgF	HF		AgF	HF		AgF	HF	
87.5	0.40	1:4	137.0	0.40	1:4	178.0	0	1:2
89.4	2.60	"	145.0	2.60	"	178.5	1.73	"
93.8	3.97	"	162.0	6.40	1:4 + 1:2	177.65	5.42	"
118.5	9.60	"	169.5	14.50	1:2	179.5	10.0	"
156.0	14.0	1:4 + 1:2	187.0	19.35	1:2	189.5	13.4	"
159.0	17.2	1:2	193.0	21.50	AgF	191.5	14.3	1:2 + AgF(?)
185.0	24.0	"	186.0	27.00	"	207.0	0.15	3:5
189.0	25.7	AgF	196.5	38.00	"	206.2	1.25	"
188.0	29.5	"	201.0	42.50	AgF + 1:2F	202.5	7.9	"
196.0	39.8	"	134.5	56.40	1:2F	198.6	12.65	"
142.1	52.0	1:2	163.0	0.40	1:2	195.5	11.7	1:1
121.75	57.2	"	162.0	5.68	"	194.5	13.0	"
94.93	66.57	"	190.0	0.40	3:5	189.5	18.8	3:5 + AgF(?)
173.75	0.4	3:5	189.0	8.10	"	193.0	36.6	AgF
174.0	3.6	"	189.8	14.90	"	193.5	16.0	"

1:1 = AgF·H₂O 1:4 = AgF·4H₂O 1:2F = AgF·2HF
1:2 = AgF·2H₂O 3:5 = 3AgF·5H₂O

EQUILIBRIA IN THE SYSTEM SILVER FLUORIDE - MAGNESIUM FLUORIDE - WATER
AT 25°

(Talipov, Abdullaeva and Kirsanova, 1953)

gms. per 100 gms. sat. sol.		Solid Phase
AgF	MgF ₂	
0.505	0.004365	MgF ₂
0.505+	Trace	"
46.4	"	"

SOLUBILITY OF SILVER FLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952; Fredenhagen and Cadenbach, 1930;
Fredenhagen, 1931, 1933)

t°	gms. AgF per		Solid Phase
	100 gms. HF	100 ml. sat. sol.	
-25.0	27.2 ± 0.7	....	AgF·2HF
-15	....	33.0	"
-9.8	43.8 ± 0.1	....	"
+11.9	83.2 ± 0.8	....	"

Ag ARGENTUM

SOLUBILITY OF SILVER FLUORIDE IN BROMINE TRIFLUORIDE (Sheft, Hyman and Katz, 1952)

	t°	25°	70°
gms. AgF per 100 gms. sat. sol.		3.79 ± .3	4.80 ± .01

Melting point data in the system AgF + ZnF₂ are given by DeVries and Roy, 1953.

SILVER (II) FLUORIDE AgF₂

SOLUBILITY IN ANHYDROUS HYDROGEN FLUORIDE (Jaché and Cady, 1952)

	t°	(Solid Phase = AgF ₂)		
		-25.2	-8.9	+11.5
gms. AgF ₂ per 100 gms. HF		0.021 ± .001	0.030 ± .002	0.048 ± .006

SILVER FLUOBORATE AgBF₄

(SILVER BORON FLUORIDE)

THE SYSTEM SILVER FLUOBORATE - TOLUENE - WATER AT ROOM TEMPERATURE (Warf, 1952)

The results are qualitatively similar to those found in the system silver perchlorate - toluene - water (p. 82, 83).

Liquid I wt. %		Liquid II wt. %		Liquid III wt. %	
AgBF ₄	H ₂ O	AgBF ₄	H ₂ O	AgBF ₄	H ₂ O
38.4	6.22	negligibly small quantity of Liq. III		-	None -
69.3	(?)	50.0	(?)	0.56	8.4

SILVER HEXAFLUORGERMANATE Ag₂OeF₆

(SILVER GERMANO FLUORIDE)

100 cc. sat. solution of silver germano fluoride in water contain 88.03 gm. Ag₂GeF₆ at 30°. (Müller, 1927.)

SILVER FLUOPHOSPHATE Ag₂PO₃F

(SILVER PHOSPHO FLUORIDE)

One liter sat. solution in water contains 0.0593 gm. mol. Ag₂PO₃F at 20°. (Lange, 1929.)

SILVER IODIDE AgI

SOLUBILITY IN WATER

t°	gms. per liter	
20-25°	0.0000026	(Average of Kohlrausch, Abegg and Cox, Ruff, 1929, etc.)
60°	0.0000253	(Sammet, 1905)

The data of Bedell, 1938 are 5-10 times as large as those listed above. They were obtained by mixing very dilute AgOH and HI solutions until a turbidity was obtained.

I

The following approximate values are given by Garvish and Galinker, 1955. However, the 20° value found by these authors (0.000034) is in serious disagreement with those above.

300°	0.019	320°	0.038	354°	0.054
309°	0.026	349°	0.054	365°	0.067

SOLUBILITY OF AgI IN AQUEOUS SOLUTIONS OF HYDROGEN IODIDE
(Erber, 1941)

The solid phase was AgI throughout					
Results at 0°			Results at 25°		
Wt. % HI	Wt. % AgI	Density ₄	Wt. % HI	Wt. % AgI	Density ₂₅
11.6	0.248	1.096	9.8	0.093	1.075
18.7	2.34	1.192	10.9	0.140	1.084
22.9	6.76	1.304	11.9	0.208	1.092
28.0	21.3	1.647	16.1	0.60	1.127
30.2	29.1	1.888	18.9	1.70	1.177
32.2	33.0	2.066	23.5	5.04	1.271
37.7	37.9	.....	27.2	11.4	1.414
38.0	42.6	2.796	28.7	16.9	1.537
38.4	39.7	2.652	29.3	18.7	1.593
			30.7	22.7	1.695
			31.2	27.5	1.849
			31.7	32.8	2.036
			32.2	33.1	2.055
			32.0	33.5	2.069
			32.6	33.8	2.167
			33.9	41.4	2.515
			34.8	42.9	2.599
			36.0	43.4	2.724
			37.1	43.9	2.794

SOLUBILITY OF SILVER IODIDE IN NITRIC ACID, SULFURIC
ACID AND POTASSIUM HYDROXIDE SOLUTIONS
(Bedell, 1938)

The author determined the point of opalescence when AgOH and HI were mixed in the presence of HNO₃, H₂SO₄ and KOH he found that the

Ag ARGENTUM

presence of 0.000016 to 0.0026 gms. acid (or base) per liter did not sensibly affect the solubility of AgI.

SOLUBILITY OF SILVER IODIDE IN AQUEOUS AMMONIA

t°	Percent Concentration of Aq. Ammonia	d of Aq. Ammonia	Gms. AgI per liter	Authority
12	10	0.960	0.035	(Longi, 1883)
16	7	0.971	0.045	(Ladenburg, 1902)
I 16	20	0.926	0.166	(Baubigny, 1908)

SOLUBILITY OF SILVER IODIDE IN SILVER NITRATE SOLUTIONS

t°
11° 100 gms. sat. silver nitrate solution dissolve 2.3 gms. AgI
 (von Laszcynski, 1894)

25° Data of Hellwig, 1900:

Mols. AgNO ₃ per liter	AgI		Solid Phase	Mols. AgNO ₃ per liter	AgI		Solid Phase
	Mols. per liter	Gms. per liter			Mols. per liter	Gms. per liter	
0.20	0.000289	0.068	AgI	2.04	0.0458	10.9	AgI·2AgNO ₃
0.35	0.000532	0.121	"	2.54	0.0678	16.1	"
0.50	0.00127	0.299	"	3.75	0.141	33.2	"
0.70	0.00362	0.850	"	4.69	0.227	53.2	"
1.215	0.0131	3.08	AgI·AgNO ₃	5.90	0.362	85	"
1.63	0.0267	6.26	"				

At the boiling pt. 100 gms. sat. silver nitrate solution dissolve 12.3 gms. AgI. (von Laszcynski, 1894).

SOLUBILITY OF SILVER IODIDE IN AQUEOUS SOLUTIONS OF IODIDES (for HI solutions, see p. 93)

IN SODIUM IODIDE SOLUTIONS

20° (Schulz and Tezak, 1951) (read from the authors' curves)

moles per liter	{ NaI	0.043	0.17	0.50	1.07
	{ AgI	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²

24-26° (King, Krall, and Pandow, 1952)

(with added NaClO_4 : $[\text{NaI}] + [\text{NaClO}_4] = 2.0$ moles per liter in each case)

moles per liter		(selected data) moles per liter		moles per liter	
NaI	AgI	NaI	AgI	NaI	AgI
0.118	7.6×10^{-5}	0.437	1.26×10^{-3}	1.34	0.0324
0.184	15.0 "	0.584	2.70 "	1.72	.0673
0.277	38.4 "	0.766	6.14 "	1.86	.0839
0.362	76.3 "	1.06	14.2 "	1.99	.121

25° (Krym, 1909)

I

Gms. per 100 Gms. H_2O		Solid Phase	Gms. per 100 Gms. H_2O		Solid Phase
NaI	AgI		NaI	AgI	
59.29	21.21	AgI	226.0	120.9	AgI·NaI· $3\frac{1}{2}\text{H}_2\text{O}$ + NaI
67.47	28.52	"	222.7	112.1	NaI
134.1	99.54	"	214.7	90.84	"
156.9	124.6	"	203.9	59.48	"
179.8	150.0	" + AgI·NaI· $3\frac{1}{2}\text{H}_2\text{O}$	194.5	31.10	"
196.3	134.8	AgI·NaI· $3\frac{1}{2}\text{H}_2\text{O}$	185.52	0	"
223.7	122.0	"			

The above table was calculated from the original results which are expressed in mols. per 1000 mols. H_2O .

IN POTASSIUM IODIDE SOLUTIONS

15°

(Schierholz, 1890)

gms. per 100 gms. sat. sol.		gms. per 100 gms. sat. sol.	
KI	AgI	KI	AgI
59.16	53.15	33.3	7.33
57.15	40.0	25.0	2.75
50.0	25.0	21.74	1.576
40.0	13.0	20.0	0.80

20°

(Schulz and Tezak, 1951)

[as interpolated by Kratochvil and Tezak, 1954]

moles per liter		moles per liter		moles per liter	
AgI	KI	AgI	KI	AgI	KI
0.04	1.23	0.0006	0.375	0.00002	0.081
.02	1.08	.0004	.325	.00001	.054
.01	0.925	.0002	.235	.000006	.04
.006	.78	.0001	.17	.000004	.0325
.004	.7	.00006	.135	.000002	.023
.002	.575	.00004	.11	.00001	.015
.001	.45				

Ag ARGENTUM

25° (Hellwig, 1900)

KI moles per liter	AgI		KI moles per liter	AgI	
	moles per liter	gms. per liter		moles per liter	gms. per liter
0.335	0.000363	0.0853	1.406	0.0535	12.55
0.586	0.00218	0.512	1.486	0.0658	15.46
0.734	0.0044	1.032	1.6304	0.102	24.01
1.008	0.0141	3.32	1.937	0.198	46.42
1.018	0.0148	3.47			

I 40° (Schulz and Tezak, 1951) (read from the authors' curves)

moles per liter	{ KI AgI	0.14 10 ⁻⁴	0.43 10 ⁻³	0.91 10 ⁻²
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60° (Schulz and Tezak, 1951) (read from the authors' curves)

moles per liter	{ KI AgI	0.125 10 ⁻⁴	0.37 10 ⁻³	0.90 10 ⁻²
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SOLUBILITY OF SILVER IODIDE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS

Salt	t°	
Al(CNS) ₃	25°	0.02 gms. AgI dissolve in 100 gms. of solution containing 9.09 wt.% (1:10) Al(CNS) ₃ . (Valenta, 1894.)
Ba(CNS) ₂	25°	0.02 gms. AgI dissolve in 100 gms. of solution containing 9.09 wt.% (1:10) Ba(CNS) ₂ . (Valenta, 1894.)
Ba(NO ₃) ₂	20°	The presence of 0.00016 to 0.0026 gms. BaNO ₃ per liter does not sensibly affect the solubility of AgI. (Bedell, 1938.)
Ca(CNS) ₂	25°	0.03 gms. AgI dissolve in 100 gms. of solution containing 9.09 wt.% (1:10) Ca(CNS) ₂ . (Valenta, 1894.)
Hg(NO ₃) ₂ (+HNO ₃)	25°	(Morse, 1902)

Since HNO₃ was present in all cases its influence on the solubility was examined. It was found that no appreciable differences were obtained with concentrations varying between 0.1 and 2 n HNO₃. Both crystallized and amorphous silver iodide gave identical results.

Hg(NO ₃) ₂ moles per liter	AgI		Hg(NO ₃) ₂ moles per liter	AgI	
	moles per liter	gms. per liter		moles per liter	gms. per liter
0.010	0.00340	0.800	0.050	0.00740	1.737
0.0125	0.00358	0.841	0.100	0.01161	2.730
0.025	0.00476	1.118	1.000	0.10700	25.160

KBr 15° 100 gms. of a saturated solution contain 30.77 gms. KBr and 0.132 gms. AgI. (Schierholz, 1890.)

KCN 25° (Randall and Halford, 1930)
Sufficient NaOH was added to repress the hydrolysis of the cyanide.

moles per liter		moles per liter		moles per liter	
KCN	AgI	KCN	AgI	KCN	AgI
0.01837	0.00866	0.0208	0.0102	0.195	0.0913
0.03676	0.01778	0.0405	0.0191	0.261	0.1217
0.05521	0.02666	0.0836	0.0391	0.318	0.1474
0.07337	0.03549	0.146	0.0684	0.398	0.1840

I

25° 100 gms. of a 4.76 wt.% (1:20) solution dissolve 8.28 gms. AgI. (Valenta, 1894); 8.57 gms. (Cohn, 1895).

KSCN 25° (Randall and Halford, 1930)

moles per liter		moles per liter	
KSCN	AgI	KSCN	AgI
0.202	0.00002	0.608	0.000040
0.315	0.000014	0.710	0.000097
0.425	0.000067	0.765	0.000146
0.500	0.000051	1.009	0.000163

$\left. \begin{matrix} \text{KNO}_3 \\ \text{LiNO}_3 \\ \text{Mn}(\text{NO}_3)_2 \end{matrix} \right\} 20^\circ$ The presence of 0.00016 to 0.0026 gms. per liter of these salts does not sensibly affect the solubility of silver iodide. (Bedell, 1938.)

NH_4SCN 20° (Valenta, 1894)

Solvent: wt.% NH_4SCN	4.76% (5:100)	9.09% (10:100)	13.05% (15:100)
gms. AgI per 100 gms. solvent	0.02	0.08	0.13

NaCl 15° (Schierholz, 1890)

gms. per 100 gms. sat. sol.

NaCl	AgI
25.00	0.00072
26.31	0.0244

Na_2SO_3 25° (Valenta, 1894)

Solvent: wt.% Na_2SO_3	9.09% (1:10)	16.67% (1:5)
gms. AgI per 100 gms. solvent	0.01	0.02

Ag ARGENTUM

Na₂S₂O₃ 20° Solvent: 0.99% 4.76% 9.09% 13.05% 16.67%
wt. % Na₂S₂O₃ (1:100) (5:100) (10:100) (15:100) (20:100)

- gms. AgI per 100 gms. solvent -

Valenta (1894) -	0.03	0.15	0.30	0.40	0.60
Cohn (1895) -	0.623	2.996	5.726	8.218	10.493

I

SOLUBILITY OF SILVER IODIDE IN POTASSIUM IODIDE SOLUTIONS IN AQUEOUS METHANOL, ETHANOL AND ACETONE SOLUTIONS AT 20° (Kratochvil and Tezak, 1954)

KI was added to AgNO₃ solutions until the turbidity of AgI just disappeared. The solution therefore also contained KNO₃ equal to the amount of AgI dissolved. The dielectric constant D of each solvent is listed. Concentrations are given in moles per liter, solvents in weight percent. For similarly determined solubilities in pure water, see p. 95.

AgI	KI				
	methanol	ethanol		acetone	
	62% D = 50.4	50% 50.4	90% 29.0	48.5% 50.4	82% 29.0
0.04	...	...	...	0.2125	...
.02	...	0.825	...	...	...
.01	...	0.625	...	0.125	0.025
.006	...	0.55	...	...	...
.004	0.44	0.48	...	0.085	0.0125
.002	...	0.38	0.125	...	...
.001	0.25	0.28	0.0775	0.044	0.0042
.0006	...	0.22	0.0525	...	...
.0004	0.155	0.17	0.038	0.025	0.0019
.0002	...	0.105	0.02	...	...
.0001	0.0675	0.0625	0.00975	0.0105	0.000525
.00006	...	0.04	0.00575	...	...
.00004	0.0325	0.029	0.00375	0.00475	0.00023
.00002	0.0175	0.0155	0.001675	...	...
.00001	...	0.085	0.00725	0.00125	0.000115
.000006	...	0.0525	0.00574	...	...
.000004	...	0.0345	0.0022	0.0004	0.0000575

SOLUBILITY OF SILVER IODIDE IN AQUEOUS ACETONE SOLUTIONS AT 25° (Mackor, 1951)

mole % acetone	19.73	46.4	84.55	100
moles AgI per liter	6.6 x 10 ⁻⁹	2.6 x 10 ⁻⁹	1.4 x 10 ⁻¹⁰	1.05 x 10 ⁻¹¹

SOLUBILITY OF SILVER IODIDE IN AQUEOUS SOLUTIONS OF THIOUREA
(THIOCARBAMIDE) AND THIOCYANIME AT 25°
(Valents, 1894)

Compound	Solvent wt. % compd.	gms. AgI per 100 gms. solvent
Thiocarbamide (Thiourea)	9.09 (10:100)	0.79
	0.99 (1:100)	0.008
Thiocyanime	4.76 (5:100)	0.05
	9.09 (10:100)	0.09

SOLUBILITY OF SILVER IODIDE IN ANHYDROUS ORGANIC SOLUTIONS

Solvent	t°	AgI			Reference
		moles per liter	gms. per liter	gms. per 100 gms. solvent	
Methanol	20-23°	1.2×10^{-9}	2.8×10^{-7}	...	(Neustadt, 1910)
	25°	6.2×10^{-9}	1.52×10^{-6}	...	(Koch, 1930)
	25°	6.1×10^{-10}	1.43×10^{-7}	1.66×10^{-8}	(Buckley and Hartley, 1929)
Ethanol	20-23°	3.3×10^{-10}	7.8×10^{-8}	...	(Neustadt, 1910)
	25°	2.1×10^{-10}	4.9×10^{-8}	...	(Koch, 1930)
Acetone	25°	1.05×10^{-11}	2.5×10^{-9}	...	(Mackor, 1951)
Pyridine	10°	...	...	0.10	(von Laascymeki, 1894)
	121°	...	...	8.60	(")

The solubility of silver iodide in diethyl ether containing 1M LiClO_4 is 4×10^{-12} moles per liter at 23.5°. (Althin, Wahlin, and Sillen, 1949.)

SOLUBILITY OF SILVER IODIDE IN ACETONE SOLUTIONS OF
POTASSIUM IODIDE AND OF SODIUM IODIDE AT 25°
(Koch, 1930a)

Results for KI Solutions

Results for NaI Solutions

Gms. KI per 100 gms. acetone	Gms. AgI per 100 gms. sat. sol.	Gms. NaI per 100 gms. acetone	Gms. AgI per 100 gms. sat. sol.
0.69	2.802	0.272	1.235
1.27	5.020	0.824	3.656
		1.910	8.034

Ag ARGENTUM

THE SYSTEM SILVER IODIDE - IODINE - BENZENE AT 6° (Foote and Fleischer, 1940)

Gms. I ₂ per 100 gms. sat. sol.	Gms. I ₂ per 100 gms. residue	Solids Present
7.46	6.0	AgI
8.71	12.13	AgI + I ₂
8.68	196.62	"

SOLUBILITY OF SILVER IODIDE IN LIQUID AMMONIA AND IN LIQUID SULFUR DIOXIDE

t°	Solvent	Gms. AgI per 100 gms. solvent	Authority
0	NH ₃	530.9	(Linhard and Stephan, 1933, 1934)
25	NH ₃	206.84	(Hunt and Boncyk, 1933)
0	SO ₂	0.017	(Jander and Wickert, 1936; Jander and Ruppold, 1937)

Melting point data have been determined by the following systems:

AgI + AgNO ₃	(Bokovkin, 1950)
AgI + CsCl	(Raditschew, 1930)
AgI + CuCl	(")
AgI + CuI	(Jost, Krug and Sieg, 1952)
AgI + HgI ₂	(Steger, 1903)
AgI + KCl	(Rostkowski, 1929 (2))
AgI + LiCl	(Raditschew, 1930)
AgI + NaI	(Sandonnini and Scarpa, 1913)
AgI + PbI ₂	(Germann and Metz, 1931)
AgI + RbCl	(Raditschew, 1930)
AgI + NaNO ₃	AgNO ₃ + NaI (Zakharchenko and Bergman, 1955)
AgI + TlNO ₃	AgNO ₃ + TlI (Berg and Lepeshkov, 1947)
2AgI + Tl ₂ SO ₄	Ag ₂ SO ₄ + 2TlI (Platonov, 1946)

I SILVER MERCURI IODIDE Ag₂HgI₄

Melting point data for the system Ag₂HgI₄-Cu₂HgI₄ are given by Suchow and Keck, 1953.

SILVER IODIDE THIOSINAMINE (Allyl thiocarbamide)

One liter saturated solution in water contains 0.000088 gm. AgI·NH₂·CS·NHC₃H₅ at 25° and 0.0778 at 50°. (Sheppard and Hudson, 1927.)

SOLUBILITY IN WATER

The various data are in good agreement at low temperatures, but above 30° , do not lie on a smooth curve. At 25° , the individual values are 0.0503 (Hill and Simmons, 1909), 0.05008 (Kohltoff and Lingane, 1938), 0.05048 (Li and Lo, 1941), 0.05073 (Keefer and Reiber, 1941) and 0.0508 (Ricci and Amron, 1951). The earlier value of Whitby (1910) at 20° is too low; that several earlier workers at 25° too high.

t°	gms. AgIO_3 per liter sat. sol.	Reference
9.43	0.0275	(Kohlrausch, 1908)
10	.0274	(Li and Lo, 1941)
18.4	.039	(Kohlrausch, 1908)
20	.04137	(Li and Lo, 1941)
25	.0505 \pm .0002	(Average of five)
26.6	.0539	(Kohlrausch, 1908)
30	0.0686	(Li and Lo, 1941)
35	.07316	(")
45	.0996	(Ricci and Amron, 1951)
60	.1849	(Sammet, 1905)
75	.231	(Baxter, 1926)

SOLUBILITY OF SILVER IODATE IN IODIC ACID SOLUTIONS
(THE SYSTEM $\text{AgIO}_3 - \text{I}_2\text{O}_5 - \text{H}_2\text{O}$)
(Ricei and Amron, 1951)

	Saturated solution		Total Complex		Solid Phase	Saturated solution		Total Complex		Solid Phase
	% B	Density	% A	%B		% B	Density	% A	% B	
IO	19.51	1.203	3.03	18.96	A	34.55	1.410	20.01	27.53	A
	36.89	1.455	9.99	33.17	A	40.40	1.512	19.97	32.21	A
	48.64		2.99	47.21	A	46.43	1.637	20.00	36.98	A
	52.11		22	45	A,A·B	47.44	1.653	10.00	42.68	A
	52.09		20	46	A,A·B	48.42	1.681	8.99	44.10	A
	54.12		14.96	54.06	A·B	49.53	1.702	5.00	46.96	A
	55.20	1.864	5.00	55.02	A·B	49.95		21	44	A,A·B
	59.78	1.999	8.00	58.81	A·B	49.94		22	42	A,A·B
	63.04	2.12	5.01	62.15	A·B	49.94		5.01	49.81	A,A·B
	63.72		10.01	61.67	A·B	50.45	1.727	5.01	50.75	A·B
	64.69	2.18	5.00	63.57	A·B	50.99	1.737	5.00	51.24	A·B
	65.70	2.22	5.00	64.48	A·B	51.55		5.00	51.71	A·B
	67.82		5.00	66.39	A·B	52.73		15.00	53.11	A·B
	68.85		5.00	67.35	A·B	54.24	1.820	5.00	54.08	A·B
	69.86		5.00	68.29	A·B	55.30	1.849	5.00	55.03	A·B
	71.00	2.45	5.00	69.24	A·B	56.29		5.01	55.98	A·B
	71.42		5.50	69.25	A·B	57.44	1.911	5.01	56.93	A·B
	71.54	2.48; point b,	average of four		A·B,B·W	61.10		15.01	58.92	A·B
						66.74		15.00	62.59	A·B
	71.55		0.00	...	B·W	70.64	2.42	5.01	68.76	A·B
					71.69	2.47	4.98	69.71	A·B	
					72.05		14.95	66.21	A·B	
					73.24	2.54	5.00	71.14	A·B	
					74.02	2.58	2.00	74.00	A·B,B·W	
					73.89		0.00	...	B·W	

A = AgIO₃
B = I₂O₅
W = H₂O

SOLUBILITY OF SILVER IODATE IN NITRIC ACID SOLUTIONS
(Li and Lo, 1941a; Hill and Simmons, 1909; Longi, 1883)

moles HNO ₃ per 1000 cc solvent	gms AgIO ₃ per 1000 cc sat. sol.		
	25°	30°	35°
0.0	0.05048	0.06086	0.07316
.001301	.05172	...	...
.006503	.05512	.06711	.08043
.01410	.05854	.07127	.08611
.07050	.07522	.09208	.11091
.1213	.08597	.10605	.12831
.125	.0864 (H.&S.)	...	...
.250	.1075 (H.&S.)	...	...
.2528	.10803	.13399	.16086
.500	.1414 (H.&S.)	...	...
.5050	.14216	.17985	.21826
.8738	.18444		
1.00	.2067 (H.&S.)		
2.00	.3319 (H.&S.)		
4.00	.6985 (H.&S.)		
6.7	1.16 (L.)		
8.00	1.587 (H.&S.)		

SOLUBILITY OF SILVER IODATE IN AMMONIA SOLUTIONS AT 25°
(Derr, Stockdale, and Vosburgh, 1941; Mottola, 1949; Longi, 1883)

gms. per 1000 gms. H ₂ O		gms. per 1000 gms. H ₂ O	
NH ₃	AgIO ₃	NH ₃	AgIO ₃
0.2113	1.036	4.235	22.98
.2158	1.061	5.03 (d-solvent = 0.998)	23.7 (L.)
.3142	1.552	111. (d-solvent = 0.96)	505. (L.)
.5224	2.101		
.5254	2.646		
1.052	5.376		
1.751	9.115		
2.127	11.120		
3.145	16.79		

moles per liter	
0.192	0.0612(M.)
.240	.0767(M.)
.418	.1367(M.)

Ag ARGENTUM

SOLUBILITY OF SILVER IODATE IN AMMONIA SOLUTIONS CONTAINING ADDED SALTS AT 25°

(Derr, Stockdale and Vosburgh, 1941;
Vosburgh and McClure, 1943; Mottola, 1949)

IO

With Ammonium Nitrate Added
gms. per 1000 gms. H₂O

NH ₃	NH ₄ NO ₃	AgIO ₃
.00215	0.815	0.0636(V.&M.)
.00330	.815	.0676(")
.01434	0.0	.0970(")
.0698	.401	.3682(")
.1401	.817	.732(")
.2175	1.60	1.132
.2294	10.41	1.285
.2389	4.03	1.277
.6129	0.82	3.182
.6156	5.55	3.357
.6175	9.93	3.450
.6261	0.79	3.238

With Potassium Nitrate Added

NH ₃	KNO ₃	AgIO ₃
0.2120	10.09	1.145
.6163	4.07	3.247
.6178	14.40	3.427

With Cadmium Nitrate Added
moles per liter sat. sol.

NH ₃	Cd(NO ₃) ₂	AgIO ₃
0.712	0.0566	0.1365
1.20	.125	.1028
1.343	.164	.201

With Copper
Nitrate Added

NH ₃	Cu(NO ₃) ₂	AgIO ₃
0.		
0.347	0.0625	0.073
.432	.100	.0775

Mottola, 1949 also gives
data for the solubility of
AgIO₃ in ammonia solutions
containing NH₄NO₃ + Ni(NO₃)₂,
NH₄NO₃ + Zn(NO₃)₂, NH₄NO₃ +
Cu(NO₃)₂, and (NH₄)₂SO₄ +
MgSO₄.

Data for the solubility of silver iodate in ammonia solutions (0.1 -
2.2 g/1000 g H₂O) containing roughly constant amounts of both ammonium
nitrate (0.83 g/1000 g H₂O) and nickel nitrate (1.82 g/1000 g H₂O) are
given by Derr and Vosburgh, 1943.

SOLUBILITY OF SILVER IODATE IN SILVER NITRATE SOLUTIONS AT 25°

(Ricci and Amron, 1951)

Gms. per 100	{ AgNO ₃ :	22.65	48.47	70.43	71.84(sat'd.)
gms. sat. sol.	{ AgIO ₃ :	0.009	0.006	0.035	0.041

SOLUBILITY OF SILVER IODATE IN POTASSIUM IODATE SOLUTIONS

at about 20° (Shehigol, 1952)

moles per liter	{ KIO ₃	0.005	0.025	0.50
	{ AgIO ₃	0.000060	0.000500	0.000830

The Systems KIO₃ - AgIO₃ - H₂O, NaIO₃ - AgIO₃ - H₂O, LiIO₃ -
AgIO₃ - H₂O, and NH₄IO₃ - AgIO₃ - H₂O were found to be without double
salts or solid solutions at 25° by Ricci and Amron, 1951. No silver
could be detected in the solutions using the usual qualitative tests.

SOLUBILITY OF SILVER IODATE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS
(Li and Lo, 1941; Baxter, 1926; Kolthoff and Lingane, 1938)

Salt	t°	concentration of		Salt	t°	concentration of	
		Salt	AgIO ₃			Salt	AgIO ₃
grams per liter sat. sol. (Li and Lo)				mmol. per 1000 gms. H ₂ O (Baxter)			
KNO ₃	10°	0.0	0.0274	KNO ₃	75°	1.0	0.8547
		.1341	.02833			2.0	0.8660
		.3299	.02893			5.0	0.8875
		.6535	.02981			10.0	0.9158
		1.419	.03122			20.0	0.9570
	20°	7.109	.03617			50.0	1.0365
		0.0	0.04137			100.0	1.1258
		.1341	.04265	K ₂ SO ₄	75°	0.5	0.8555
		.3299	.04364			1.0	0.8760
		.6535	.04474			2.0	0.9024
	1.419	.04683	5.0			0.9603	
	7.109	.05495	10.0			1.0241	
	25°	0.0	0.05048	KClO ₃	75°	20.0	1.1110
		.1315	.05167			50.0	1.2932
		.3288	.05283			0.0	0.8403
		.6575	.05410			2.0	0.8661
		1.426	.05662			5.0	0.8900
		7.128	.06516	10.0	0.9143		
		12.26	.06940	20.0	0.9503		
		20.20	.07537(K.&L.)	50.0	1.0183		
		25.56	.07899	100.0	1.0882		
		50.50	.09372(K.&L.)	Ba(NO ₃) ₂	75°	0.5	0.8646
		51.06	.09417			1.0	0.8717
88.34		.11041	2.0			0.8973	
100.99		.11555(K.&L.)	5.0			0.9322	
30°	0.0	0.06086	MgSO ₄			75°	10.0	0.9664
	.1341	.06256		0.2	0.8522		
	.3299	.06400		0.5	0.8698		
	.6535	.06572		1.0	0.8855		
	1.419	.06841		2.0	0.9111		
	7.109	.08043		5.0	0.9629		
	12.26	.08600		10.0	1.0201		
	25.56	.09694		20.0	1.0928		
	51.06	.11411					
	35°	0.0		0.07316			
.1341		.07531					
.3299		.07675					
.6535		.07879					
1.419		.08258					
7.032		.09561					
20.25		.11518					
50.42		.13583					

Ag ARGENTUM

SOLUBILITY OF SILVER IODATE IN GLYCINE AND ALANINE SOLUTIONS AT 25°
(Keefer and Reiber, 1941)

In glycine solutions				In alanine solutions	
gms. per 1000 gms. H ₂ O		gms. per 1000 gms. H ₂ O		gms. per 1000 gms. H ₂ O	
Glycine	AgIO ₃	Glycine	AgIO ₃	Glycine	AgIO ₃
0.0	0.05073	6.181	0.05597	2.237	0.05351
1.884	.05257	7.563	.05713	3.332	.05441
2.829	.05317	9.294	.05889	5.003	.05659
3.773	.05418	12.42	.06168	6.733	.05837
5.657	.05574	15.33	.06287	8.991	.06094

SOLUBILITY OF SILVER IODATE IN PYRIDINE SOLUTIONS AT 25°
(Vosburgh and Cogswell, 1943)

gms. per 1000 gms. H ₂ O		gms. per 1000 gms. H ₂ O		gms. per 1000 gms. H ₂ O	
Pyridine	AgIO ₃	Pyridine	AgIO ₃	Pyridine	AgIO ₃
3.93	0.3060	11.81	0.8736	32.4	2.395
4.33	.3337	11.85	0.8829	40.8	3.015
4.52	.3484	15.96	1.1801	40.8	3.032
7.89	.5894	16.30	1.1846	57.6	4.256
8.01	.6024	23.94	1.773	67.5	4.983
8.50	.6346	32.4	2.392		

10 SILVER PERIODATE AgIO₄

EQUILIBRIUM IN THE SYSTEM Ag₂O - I₂O₇ - H₂O
(Gyani, 1950, 1951)

sat. sol. wt. %		wet residue wt. %		Solid Phase
Ag ₂ O	I ₂ O ₇	Ag ₂ O	I ₂ O ₇	
Results at 0°				
Trace	Trace	31.28	8.15	Ag ₂ O + 5Ag ₂ O·I ₂ O ₇
"	0.0235	19.70	6.32	5Ag ₂ O·I ₂ O ₇
"	.0252	25.82	8.27	"
0.0016	.0306	19.09	12.88	5:1 + 2Ag ₂ O·I ₂ O ₇ ·3H ₂ O
.0025	1.321	17.00	14.16	2Ag ₂ O·I ₂ O ₇ ·3H ₂ O
.0039	13.07	13.34	20.31	"
.0064	21.87	15.96	27.67	"
.0175	35.48	12.76	37.03	"
.0236	39.13	15.77	39.76	"
.0460	49.72 av.	...	...	2:1:3 + Ag ₂ O·I ₂ O ₇ ·4H ₂ O
.0398	52.11	16.71	53.11	Ag ₂ O·I ₂ O ₇ ·4H ₂ O
.0409	57.77	18.96	56.29	"
.0203	60.95	16.47	57.93	"
Trace	62.53	2.33	69.75	1:1:4 + I ₂ O ₇ ·5H ₂ O
...	62.51	...	...	I ₂ O ₇ ·5H ₂ O

(Cont.)

EQUILIBRIUM IN THE SYSTEM $\text{Ag}_2\text{O} - \text{I}_2\text{O}_7 - \text{H}_2\text{O}$ —Cont.

Sat. sol. wt. %		wet residue wt. %		Solid Phase
Ag ₂ O	I ₂ O ₇	Ag ₂ O	I ₂ O ₇	
Results at 35°				
'Small'	0.00	...	...	Ag ₂ O + 5Ag ₂ O·I ₂ O ₇
"	0.00	31.22	9.73	5Ag ₂ O·I ₂ O ₇
"	0.04	23.23	7.40	"
"	0.05	27.12	8.63	"
"	0.06 av.	...	...	5:1 + 2Ag ₂ O·I ₂ O ₇ ·H ₂ O
"	0.18	16.36	13.16	2Ag ₂ O·I ₂ O ₇ ·H ₂ O
"	1.22	36.66	29.10	"
"	3.30	29.08	24.53	"
"	15.53	35.91	32.72	"
"	26.41	35.93	37.18	"
"	34.50	30.41	39.31	"
"	50.83 av.	...	...	2:1:1 + Ag ₂ O·I ₂ O ₇
"	56.56	13.06	...	Ag ₂ O·I ₂ O ₇
"	61.01	15.35	...	"
"	63.73 av.	...	...	1:1 + I ₂ O ₇ ·5H ₂ O
"	63.81	...	...	I ₂ O ₇ ·5H ₂ O

SILVER PERMANGANATE AgMnO_4

MnO

SOLUBILITY OF SILVER PERMANGANATE IN AQUEOUS
SOLUTIONS OF SILVER PERCHLORATE AT 20°
(Hein and Daniel, 1937)

Gm. Mole. per liter		
AgClO_4	AgMnO_4	
0.00	0.04066	(= 9.222 gms.)
0.0565	0.0068	
0.6106	0.0049	
0.7595	0.0045	
1.0096	0.0043	
1.1196	0.0036	

SOLUBILITY OF SILVER PERMANGANATE IN AQUEOUS
SOLUTIONS OF SILVER NITRATE AT 20°
(Hein and Daniel, 1937)

Gm. Mols. per liter		Gm. Mols. per liter		Gm. Mols. per liter	
AgNO_3	AgMnO_4	AgNO_3	AgMnO_4	AgNO_3	AgMnO_4
0.00	0.04066	0.3516	0.0100	2.1067	0.0113
0.0592	0.0268	0.4613	0.0095	2.6888	0.0132
0.1170	0.0172	0.5748	0.0092	3.1650	0.0150
0.1767	0.0143	0.6944	0.0088	3.6224	0.0176
0.1782	0.0138	0.8089	0.0083	6.0616	0.0344
0.2348	0.0124	1.1516	0.0084	8.3662	0.0538
0.2891	0.0109	1.6909	0.0091	9.0373	0.0627

Ag ARGENTUM

MoO SILVER MOLYBDATE Ag_2MoO_4

SOLUBILITY IN WATER (Ricci and Linke, 1951)

Temp.	mg. Ag_2MoO_4 per 100 gms. sat. sol.	Temp.	mg. Ag_2MoO_4 per 100 gms. sat. sol.
10°	2.60	40°	5.19
25°*	3.86	45°	5.69
30°	4.16	60°	8.23
35°	4.68	70°	9.74

*100 cc of water at 25° dissolve 0.0044 gms. Ag_2MoO_4 (McCay, 1934).

No compounds or solid solutions are formed in the systems AgMoO_4 - AgNO_3 - H_2O and Ag_2MoO_4 - Na_2MoO_4 - H_2O at 25°. (Ricci and Linke, 1951.)

Melting point data are given for the systems $\text{Ag}_2\text{MoO}_4 + \text{Na}_2\text{SO}_4 \rightleftharpoons \text{Ag}_2\text{SO}_4 + \text{Na}_2\text{MoO}_4$ and for the binary systems $\text{Ag}_2\text{MoO}_4 + \text{Na}_2\text{MoO}_4$ and $\text{Ag}_2\text{MoO}_4 + \text{Ag}_2\text{SO}_4$ by Belyaev and Doroshenko, 1954.

N SILVER AZIDE AgN_3

The solubility at 25°:

2.88×10^{-9} from EMF measurements (Suzuki, 1952)

$1.6 \pm 0.2 \times 10^{-9}$ from Radioactive tracer measurements (Leden and Schoon, 1954)

NO SILVER NITRITE AgNO_2

SOLUBILITY IN WATER (Creighton and Ward, 1915; Bureau, 1937)

The original data of Creighton and Ward are starred(*). Results at other temperatures were read from a plot of their data.

AgNO_2			AgNO_2		
t°	gms. per 100 gms. sat. sol.	moles per liter	t°	gms. per 100 gms. sat. sol.	moles per liter
0	0.155	....	30	0.500	...
1	0.1589	0.01031*	35	0.6016	0.03903*
10	0.220	....	40	0.715	...
15	0.2752	0.01788*	50	0.995	...
20	0.340	....	51	1.0240	0.06654*
21	....	0.0235(Bureau)	60	1.3625	0.08855*
25	0.4135	0.02693*			

The determinations by Abegg and Pick (1906) are slightly higher than the above at temperatures below 20°. Single determinations agreeing well with the above are given by Ley and Schaefer (1906), and by von Niementowski and von Roszkowski (1897).

SOLUBILITY OF SILVER NITRITE IN SILVER NITRATE SOLUTIONS
(Naumann and Rucker, 1905 (18°); Creighton and Ward, 1915 (25°);
See also Abegg and Pick, 1905 (25°)

Results at 18°

Grams per liter		Mols. per liter	
AgNO ₃	AgNO ₂	AgNO ₃	AgNO ₂
0.000	3.184	0.0000	0.02067
0.439	3.042	0.00258	0.01975
0.878	2.926	0.00517	0.01900
1.756	2.601	0.01033	0.01689
3.512	2.201	0.02067	0.01435
7.024	1.799	0.04134	0.01168
14.048	1.480	0.08268	0.00961

Results at 25°

Mols. AgNO ₃ per liter Solvent	Dissolved AgNO ₂ per liter of solvent(?)	
	Mols.	Gms.
0	0.0269	4.135
0.00258	0.0260	3.991
0.00588	0.0244	3.735
0.01177	0.0224	3.432
0.02355	0.0192	2.943
0.04710	0.0164	2.498

NO

EQUILIBRIUM IN THE SYSTEM SILVER NITRITE - SODIUM NITRITE - WATER AT 25°
(Cavalca, Nardelli, and Braibanti, 1953)

Sat. sol. wt. %		wet residue wt. %		Solid Phase
AgNO ₂	NaNO ₂	AgNO ₂	NaNO ₂	
0.79	5.95	83.54	1.41	AgNO ₂
3.48	17.37	85.31	3.06	"
5.58	22.55	93.12	3.31	"
8.54	27.67	87.43	5.05	"
11.55	31.77	93.35	4.24	"
12.13	32.21	73.26	24.31	AgNO ₂ + NaAg(NO ₂) ₂
10.76	34.91	68.26	30.18	NaAg(NO ₂) ₂
9.79	37.23	67.76	30.56	"
8.76	39.73	65.90	31.17	"
8.58	40.68	67.28	31.22	"
7.53	43.86	23.99	69.76	NaAg(NO ₂) ₂ + Solid Solution
6.91	44.28	7.48	83.62	Solid Solution
6.17	44.58	6.68	81.25	"
5.42	44.86	5.52	82.37	"
4.35	45.15	3.81	82.50	"
3.93	45.59	2.72	86.85	"
2.81	45.62	1.94	90.72	"
2.19	45.69	1.16	81.11	"
0.0	45.92	...	...	NaNO ₂

One liter aqueous 0.02 $\frac{n}{n}$ NaNO₂ dissolves 3.185 gms. AgNO₂ at 25°

" " " 0.20 $\frac{n}{n}$ " " 3.016 " " " "

(Ley and Schaefer, 1906)

Ag ARGENTUM

EQUILIBRIUM IN THE SYSTEM SILVER NITRITE - POTASSIUM NITRITE - WATER (Creighton and Ward, 1915; Ostwald, 1914; Nardelli, Cavalca and Braibanti, 1952)

Sat. sol. wt. %		wet residue wt. %		Solid Phase
AgNO ₂	KNO ₂	AgNO ₂	KNO ₂	
Results at 13.5° (Ostwald)				
1.96	15.0	...	...	AgNO ₂ + KAg(NO ₂) ₂ · $\frac{1}{2}$ H ₂ O
6.54	68.6	...	...	KAg(NO ₂) ₂ · $\frac{1}{2}$ H ₂ O + KNO ₂
Results at 25° (N., C. & B.)				
0.75	5.83	87.76	1.65	AgNO ₂
1.99	13.19	89.46	1.68	"
4.93	21.73	78.05	17.72	AgNO ₂ + KAg(NO ₂) ₂ · $\frac{1}{2}$ H ₂ O
(4.1	18.0 ) *	...	...	" + "
4.89	24.97	60.65	33.77	KAg(NO ₂) ₂ · $\frac{1}{2}$ H ₂ O
4.88	28.09	...	...	"
5.01	32.90	59.18	34.42	"
5.09	35.11	...	...	"
5.33	38.15	60.01	34.67	"
5.57	42.02	...	...	"
6.30	48.83	...	...	"
6.78	52.55	60.44	34.23	"
7.28	55.60	61.02	34.20	"
7.88	57.47	60.31	35.35	"
8.10	60.08	59.66	35.15	"
8.31	60.90	60.09	34.92	"
8.59	61.02	59.47	35.67	"
10.53	73.14	45.06	52.28	KAg(NO ₂) ₂ · $\frac{1}{2}$ H ₂ O + KNO ₂
(9.39	66.7 ) *	...	...	" + "
4.14	74.15	0.90	93.80	KNO ₂
...	76.22	...	...	"

*Ostwald

Data of Creighton and Ward at 25°

Mola. KNO ₂ per liter solvent	Dissolved AgNO ₂ per liter (of solvent?)	
	Mols.	Gms.
0	0.0269	4.135
0.00258	0.0259	3.974
0.00588	0.0249	3.820
0.01177	0.0232	3.560
0.02355	0.0203	3.119
0.04710	0.0181	2.765

THE SYSTEM SILVER NITRITE - BARIUM NITRITE - WATER

(Ostwald, 1912, 1914 at 13.5°;

Nardelli, Cavalcia, and Braibanti, 1955 at 21°, 25°, and 35°)



Ostwald's double salt (1:2:1) was not found in the more recent work. The 2:5:1/2 double salt is stable above 22-23°.

gms. per 100 gms. sat. sol.			gms. per 100 gms. sat. sol.			NO
AgNO_2	$\text{Ba}(\text{NO}_2)_2$	Solid Phase	AgNO_2	$\text{Ba}(\text{NO}_2)_2$	Solid Phase	
Results at 13.5°			Results at 25° (cont'd.)			
5.86	36.7	$\text{AgNO}_2 + 1:2:1$ (?)	5.98	46.25	$1:1:1 + \text{Ba}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$	
5.13	40.8	$1:2:1 + \text{Ba}(\text{NO}_2)_2$	2.67	44.42	$\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
			-	44.38	"	
Results at 21°			6.97*	42.95	2:5:1/2	
4.81	34.88	AgNO_2	7.20*	44.02	"	
5.48	37.31	"	7.27*	45.56	"	
5.92	39.00	" + 1:1:1	7.23*	45.86	"	
5.93	39.27	" + 1:1:1	7.34*	46.68	$2:5:1/2 + \text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
5.55	40.85	1:1:1	7.33*	46.47	" + "	
5.46	42.57	"	6.36*	46.33	$\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
5.27	43.37	"				
5.20	43.67	"	Results at 35°			
5.18	44.43	$1:1:1 + \text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	6.52	36.38	AgNO_2	
5.22	44.79	" + "	8.03	40.09	"	
2.49	43.19	$\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	8.53	41.53	"	
0.0	42.31	"	8.89	42.68	2:5:1/2	
Results at 25°			8.87	43.92	"	
0.51	5.16	AgNO_2	9.03	46.08	"	
1.55	16.25	"	9.13	48.51	"	
3.22	26.64	"	9.30	48.91	$2:5:1/2 + 1:1:1$	
6.16	38.32	"	8.86	50.20	1:1:1	
6.32	38.94	"	8.76	50.62	$1:1:1 + \text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
6.45	39.24	"	4.69	50.29	$\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
6.72	40.38	" 2:5:1/2	-	49.25	"	
6.61	40.58	" + "	9.30*	49.18	2:5:1/2	
6.71	41.06	2:5:1/2	9.33*	49.17	2:5:1/2	
6.86	52.25	$2:5:1/2 + 1:1:1$	9.48*	50.53	$2:5:1/2 + \text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	
6.30	44.20	1:1:1				
6.18	44.97	1:1:1	*metastable			

THE SYSTEM SILVER NITRITE - STRONTIUM NITRITE - WATER AT 14°

(Ostwald, 1912, 1914)

gms. per 100 gms. sat. sol.		Solid Phase
AgNO_2	$\text{Sr}(\text{NO}_2)_2$	
5.76	41.4	$\text{AgNO}_2 + \text{Sr}(\text{NO}_2)_2$ (?)

Ag ARGENTUM

SOLUBILITY OF SILVER NITRITE IN SODIUM NITRATE SOLUTIONS AT 25°

One liter of aqueous 0.20 molar NaNO_3 dissolves 4.956 gms. AgNO_2 . (Ley and Schaefer, 1906)

Extraction of Silver Nitrite from KNO_2 solution with Ethanol

One of the two layers obtained by mixing an equal volume or more of 96% ethyl alcohol with a nearly saturated aqueous solution of KNO_2 , the lower contains 71.9% KNO_2 and the upper, alcoholic, 6.9%. With methyl alcohol there is no separation into two layers. Donath, 1911.)

SOLUBILITY OF SILVER NITRITE IN ACETONITRILE (Scholl and Steinkopf, 1906)

Temperature	"ordinary"	81.6° (b.pt.)
gms. AgNO_2 per 100 gms. acetonitrile	23	40

NO SILVER NITRATE AgNO_3

SOLUBILITY IN WATER

Although the solubility has been determined many times there is a surprising lack of agreement among the various results. The most recent work of Campbell and Boyd (1943) includes 37 determinations from -7 to +200° which fall on a smooth curve. The authors used recrystallized silver nitrate and water which had been distilled from alkaline permanganate and baryta with a tin condenser. Silver was determined by electrolytic deposition. From 115° to 145° equilibrium was attained in a glass lined bomb under pressure, and above 145° weighed amounts of water and silver nitrate were sealed together in a glass tube, melted, and cooled until crystallization occurred. Furnace temperatures were measured with a thermocouple to 0.1°. The data listed below were read from a plot of the author's results. The earlier data of Kazantzev, 1923, 1925 are higher at all temperatures; the average values from the curve given by the results of Greenish and Smith, 1903; Schreinemaker and de Baat, 1910(a); Masson, 1911; and Bailey, 1930 are lower at low temperatures and higher above 20°. Above 100°, Benrath's data do not reveal the rather clear break in curve that was found by Campbell and Boyd ($\alpha\text{AgNO}_3 \rightleftharpoons \beta\text{AgNO}_3$ at about 160°). Benrath's data from 100° to 160° do not seem to be continuous with results at lower temperatures. Various recent individual values at about room temperature agree with one or another of the values given in the table. (Ricci and Linke, 1951: 71.82% at 25°) (Cohen, de Meester and Moesveld, 1924: 73.82% at 30°.)

ARGENTUM Ag

gms. per 100 gms. sat. sol.

gms. per 100 gms. sat. sol.

t°	Campbell and Boyd, 1943	Kazantzev, 1923, 1925	Average: G.&S.; S&B M., B.	t°	Campbell and Boyd, 1943	Beurath, Gjedebo, Shiffero and Wunderlich, 1937
-1.89	10.41	Solid phase ICE		80	85.4	...
-3.55	19.72			85	86.1	...
-5.00	30.04			90	86.7	...
-6.36	39.16			95	87.4	...
-7.22	44.72			100	88.0	90.0
-7.57e	46.9	47.1*(-7.3)	-	110	89.2	91.4
-5	49.3	-	-	120	90.5	92.5
0	54.8	55.6	54.0	130	91.7	93.7
5	59.2	-	-	140	92.8	94.8
10	62.6	63.3	61.8	150	94.3	96.0
15	65.7	66.6	65.5	155	95.5	...
20	68.4	69.5	68.6	160 β	96.4	96.7
25	70.7	71.8	71.0	170 β	97.2	97.4
30	72.6	74.0	73.2	180 β	97.9	98.1
35	74.2	76.0	75.4	190 β	98.7	98.8
40	75.7	-	-	200 β	99.3	99.5
45	77.5	-	-	210 β mpt.		100
50	78.9	80.2	-			
55	80.2	-	-			
60	81.5	-	-			
65	82.6	-	-			
70	83.8	-	-			
75	84.7	85.5	-			

e = eutectic; solid phases ICE + α-AgNO₃

* = Value of Middleberg, 1903.

β = Solid phase β-AgNO₃

SOLUBILITY OF SILVER NITRATE IN AQUEOUS NITRIC ACID

(Kazantzev, 1923, 1925; Masson, 1911;

see also Schultz, 1860)

Gms. AgNO₃ per 100 gms.
sat. solution

Gms. HNO ₃ per 100 gms. sat. sol.	0°	15°	d ₁₅ [°] sat. sol.	30° (M.)		d ₃₀ [°] sat. sol. (M.)	50°	100°
5.0	38.2	50.5	(1.742)	59.1	59.2	(1.970)	67.9	80.5
10.0	27.8	38.3	(1.552)	46.8	46.0	(1.722)	56.2	71.3
15.0	21.1	29.0	(1.444)	36.8	35.8	(1.579)	46.0	62.3
20.0	16.2	22.0	(1.385)	28.9	28.0	(1.484)	36.7	54.0
30.0	10.0	13.7	(1.352)	17.7	17.0	(1.400)	23.3	38.7
40.0	6.4	8.5	(1.357)	11.2	10.6	(1.381)	14.3	25.7
50.0	4.0	5.2	(1.377)	7.0	6.6	(1.389)	8.6	15.7
60.0	2.1	3.0	(1.402)	3.9	3.0	(1.403)	5.8	99.6
70.0	-	1.4	-	2.3	-	-	3.3	-
80.0	-	0.8	-	0.9	-	-	1.5	-
95.0	-	1.2	-	1.2	-	-	1.2	-
96.5	-	1.3	-	-	-	-	-	-

Ag ARGENTUM

THE SYSTEM SILVER NITRATE - BARIUM NITRATE - WATER AT 30° (de Baat, 1918)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
AgNO ₃	Ba(NO ₃) ₂		AgNO ₃	Ba(NO ₃) ₂	
0.0	10.4	Ba(NO ₃) ₂	44.11	4.57	Ba(NO ₃) ₂
8.07	7.36	"	61.87	3.58	"
20.69	5.77	"	71.62	2.57	" + AgNO ₃
26.17	5.05	"	73.06	0.68	AgNO ₃
41.39	4.69	"	73.00	0.0	"

NO

THE SYSTEM SILVER NITRATE - POTASSIUM NITRATE - WATER

The detailed study of the 30° isotherm (in H₂O and in 51.6% alcohol) by Schreinemakers (1908-9) shows the presence of a 1:1 double salt and the absence of solid solution. Herz (1905) and Fock (1897) had thought that their solid phase at 25° (KNO₃) contained small amounts of AgNO₃. Etard (1894) did not analyze the solids and apparently did not realize a double salt was present. However, it seems evident that Etard's saturating phases are KNO₃ + AgNO₃·KNO₃.

Results at 30° (Schreinemakers, 1908-9)

In Water			In 51.6% Ethanol		
Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Solution		Solid Phase
KNO ₃	AgNO ₃		KNO ₃	AgNO ₃	
31.3	0.0	KNO ₃	4.8	0.0	KNO ₃
30.45	11.51	"	4.55	5.15	"
29.22	23.59	"	4.11	16.47	"
26.58	39.09	"	4.26	21.28	" + AgNO ₃ ·KNO ₃
25.02	46.38	" + AgNO ₃ ·KNO ₃	2.62	36.94	AgNO ₃ ·KNO ₃ + AgNO ₃
17.38	57.85	AgNO ₃ ·KNO ₃	0.0	37.00	AgNO ₃
13.44	65.08	"			
11.22	69.01	" + AgNO ₃			
5.53	71.65	AgNO ₃			
0.0	73.00	"			

(Cont.)

Results at 25°
(Herz, 1905;
Fock, 1897)
Solid Phase KNO_3 ,
Gms. per liter

Results at various temperatures
(Etard, 1894)

Solid Phase $\text{KNO}_3 + \text{AgNO}_3 \cdot \text{KNO}_3$
Gms. per 100
Gms. Sol.

AgNO_3	KNO_3	t°	KNO_3	AgNO_3	t°	KNO_3	AgNO_3	
45.9	321.8	0	13.5	43.0	50	32.0	54.0	
110.7	322.6	10	19.0	44.7	60	33.5	54.8	
176.8	333.7	20	23.0	47.0	80	36.2	55.1	
259.6	364.0	25	25.0	48.0	100	38.3	55.3	
365.6	456.4	30	26.8	49.4	120	40.0	55.6	
507.9	387.2	40	29.6	51.5	140	41.5	55.8	NO
745.9	398.6							

THE SYSTEM SILVER NITRATE - AMMONIUM NITRATE - WATER
(Schreinemakers and de Baat, 1910)

Results at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
AgNO_3	NH_4NO_3		AgNO_3	NH_4NO_3	
0.0	70.1	NH_4NO_3	45.85	34.47	D
12.51	63.59	"	52.45	28.86	"
21.31	58.64	"	57.93	24.33	"
27.75	54.12	"	58.88	23.42	D + AgNO_3
29.76	52.50	$\text{NH}_4\text{NO}_3 + \text{D}$	63.27	15.62	AgNO_3
35.62	45.44	D	69.08	6.59	"
41.09	39.60	"	73.00	0.0	"

D = $\text{NH}_4\text{NO}_3 \cdot \text{AgNO}_3$

Ag ARGENTUM

Results at various temperatures
(Schreinemakers and de Baat, 1910)

t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	AgNO ₃	NH ₄ NO ₃	
-7.3	47.1	0	Ice + rb. AgNO ₃
-10.7	44.52	8.43	"
-14.9	42	16.8	Ice + D + rb. AgNO ₃
-14.8	39.51	18.79	" + D
-18.7	15.99	37.3	" + D + β rb. NH ₄ NO ₃
NO -17.4	0	41.2	" + rb. NH ₄ NO ₃
0	50.36	19.59	D + rb. AgNO ₃
	22.13	44.87	D + rb. NH ₄ NO ₃
18	55.36	22.06	D + rb. AgNO ₃
	27.07	49.22	D + rb. NH ₄ NO ₃
30	58.89	23.42	D + rb. AgNO ₃
	29.76	52.50	D + rb. NH ₄ NO ₃
32	...	...	D + rb. NH ₄ NO ₃ + α-rb. NH ₄ NO ₃
40	32.68	52.22	D + α-rb. NH ₄ NO ₃
55	63.32	26.12	D + rb. AgNO ₃
	36.6	52.38	D + α-rb. NH ₄ NO ₃
85.4	...	...	D + rb. NH ₄ NO ₃ + rbd. NH ₄ NO ₃
101.5	47.5	52.5	D + rbd. NH ₄ NO ₃
109.6	67.9	32.1	D + rb. AgNO ₃

D = NH₄NO₃·AgNO₃. rb. = rhombic. rbd. = rhombohedric.

The melting points and vapor pressures for the system AgNO₃ - NH₄NO₃ - H₂O from the eutectic to the melting points of the salts are given by Dingermans (1943).

Results in aqueous ethanol at 30°
(Schreinemakers, 1908-09)

In 41.8% Ethanol wt. %		In 71.23% Ethanol wt. %		In 91.3% Alcohol wt. %		Solid Phase
AgNO ₃	NH ₄ NO ₃	AgNO ₃	NH ₄ NO ₃	AgNO ₃	NH ₄ NO ₃	
45.0	0.0	19.0	0.0	7.0	0.0	AgNO ₃
46.65	6.41	22.14	4.36	7.70	2.20	"
47.69	13.18	24.28	9.90	9.38	7.23	"
48.41	20.96	25.59	11.61	8.45	4.68	" + D
46.71	22.07	18.01	20.14	6.58	5.74	D
37.68	29.07	14.84	27.59	...	...	D
24.88	44.69	14.65	28.87	4.29	9.67	D + NH ₄ NO ₃
12.12	49.25	6.67	28.23	2.09	9.42	NH ₄ NO ₃
0.0	53.2	0.0	29.0	0.0	9.0	"

THE SYSTEM SILVER NITRATE - SODIUM NITRATE - WATER (+ ETHANOL)
(Hissink, 1900)

Results at 25° in				Results at 50° in			
Aq. C ₂ H ₅ OH of d ₂₀ = 0.945 (37 wt.%)				Aq. C ₂ H ₅ OH of d ₁₇ = 0.859 (75 wt.%)			
Gms. per 100		Wt. per cent		Gms. per 100		Wt. per cent	
Gms. Sol.		in Mix Crystals		Gms. Sol.		in Mix Crystals	
AgNO ₃	NaNO ₃	AgNO ₃	NaNO ₃	AgNO ₃	NaNO ₃	AgNO ₃	NaNO ₃
47.32	0.0	100	0.0	29.78	0.0	100	0.0
44.01	8.78	99.1	0.9	27.9	2.5	99.5	0.5
36.78	20.42	42.9	57.1	26.4	4.2	99.3	0.7
29.97	23.2	33.6	66.4	23.0	6.3	42.9	57.1
24.56	24.82	27.6	72.4	18.3	7.1	31.0	69.0
8.02	26.41	9.9	90.1	9.5	8.3	17.5	82.5
0.0	26.77	0.0	100.0	0.0	8.54	0.0	100.0

NO

THE SYSTEM SILVER NITRATE - LEAD NITRATE - WATER AT 25°
(Nardelli and Braibanti, 1953)

[Many other physical properties of the system were determined
by Nayar and Pande, 1948]

Gms. per 100 gms. Sat. Sol.		Solid Phase	Gms. per 100 gms. Sat. Sol.		Solid Phase
Pb(NO ₃) ₂	AgNO ₃		Pb(NO ₃) ₂	AgNO ₃	
34.29	11.21	Pb(NO ₃) ₂	22.39	49.25	Pb(NO ₃) ₂
31.11	23.28	"	18.68	56.63	"
29.17	29.81	"	17.45	58.64	Pb(NO ₃) ₂ + AgNO ₃
27.21	35.28	"	11.50	63.17	AgNO ₃
24.84	41.84	"	6.79	66.79	"
22.79	46.86	"			

Melting points and vapor pressures of the system AgNO₃ - NH₄NO₃ -
Pb(NO₃)₂ - H₂O are given by Dingermans and Dijkgraaf (1947).

SOLUBILITY OF SILVER NITRATE IN AQUEOUS ETHYL ALCOHOL
(Eder, 1878)

Sp. Gr. of Aq. Alcoholic Mixture	Volume per cent Alcohol	Gms. AgNO ₃ per 100 Gms. Aq. Alcohol at:		
		15°		
		50°	75°	
0.815	95	3.8	7.3	18.3
0.863	80	10.3	...	42.0
0.889	70	22.1	...	...
0.912	60	30.5	58.1	89.0
0.933	50	35.8	...	...
0.951	40	56.4	98.3	160.0
0.964	30	73.7	...	...
0.975	20	107.0	214.0	340.0
0.986	10	158.0	...	...

EQUILIBRIUM IN THE SYSTEM SILVER NITRATE, PHENOL AND WATER AT 25°
(Bailey, 1930)

	d_{25} of sat. solution	Gms. per 100 gms. sat. sol.		Gms. per 100 gms. residue		Solid Phase
		AgNO ₃	C ₆ H ₅ OH	AgNO ₃	C ₆ H ₅ OH	
NO	2.317	71.0	0.0	...	...	AgNO ₃
	2.297	76.8	1.1	96.1	0.4	"
	2.283	69.9	3.9	94.7	0.5	"
	2.170	66.0	13.6	92.2	2.7	"
	2.093	63.4	18.6	90.0	5.0	"
	1.878	54.1	34.1	85.9	10.0	"
	1.812	51.4	39.0	85.3	10.7	"
	1.736	47.0	46.2	92.2	5.8	"
	1.688	44.6	50.9	89.7	8.5	"
	1.633	42.4	57.6	...	...	"
	...	9.3	86.6	2.6	96.2	C ₆ H ₅ OH
	...	24.0	76.0	...	...	"
	...	0.0	95.7	...	...	"
	...	1.4	9.6	1.1	66.9	Two liquid layers
	...	3.4	12.8	3.5	60.6	
	...	5.3	19.0	5.6	47.8	
	...	6.0	31.0	(Critical point)		

EQUILIBRIUM IN THE SYSTEM SILVER NITRATE, GUANIDINE NITRATE
AND WATER AT 25°
(Sisokin, 1927)

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
CH ₅ N ₃ ·HNO ₃	AgNO ₃	CH ₅ N ₃ ·HNO ₃	AgNO ₃
0.0	72.0	2.3	22.2
1.1	70.9	6.5	13.9
0.05	71.96	12.4	8.6
0.4	67.1	12.2	8.7
0.4	57.0	12.7	7.2
1.0	48.9	12.7	6.3
1.0	34.7	13.9	0.0

The solid phase 2AgNO₃·CH₅N₃·HNO₃ was obtained.

THE SYSTEM SILVER NITRATE - SUCCINONITRILE - WATER

Very extensive data for equilibrium in the system silver nitrate, succinic acid nitrile and water are given by Middelberg (1903). This author first gives data for the ternary systems and then results for isotherms of the ternary system at 0°, 12°, 20°, 25° and 26.5°. A number of determinations for higher temperatures are also given. The following compounds of succinonitrile and silver nitrate were identified. C₂H₄(CN)₂·4AgNO₃, C₂H₄(CN)₂·2AgNO₃, C₂H₄(CN)₂·AgNO₃, 2C₂H₄(CN)₂·AgNO₃·H₂O, and 4[C₂H₄(CN)₂·AgNO₃]H₂O. Additional data for this system are also given by Timmermans (1907).

DISTRIBUTION OF SILVER NITRATE BETWEEN WATER AND ANILINE AT 15-17°
(Frumkin and Kulvarskaja, 1924)

Concentration of AgNO ₃ in			Concentration of AgNO ₃ in		
H ₂ O layer (C ₁)	C ₆ H ₅ NH ₂ layer (C ₂)	C ₂ /C ₁	H ₂ O layer (C ₁)	C ₆ H ₅ NH ₂ layer (C ₂)	C ₂ /C ₁
0.00533	0.900	173	0.00051	0.0190	37
0.00187	0.198	106	0.00020	0.00695	23
0.00082	0.067	82	0.00012	0.00170	14

The authors do not define the terms in which the concentration is expressed.

NO

SOLUBILITY OF SILVER NITRATE IN VARIOUS MIXTURES CONTAINING ETHYL ETHER

Solvent	t°	Gms. AgNO ₃ per 100 gms. solvent	
H ₂ O sat'd. w. ether	15	88.4	(Eder, 1878)
80 ml ether + 20 ml HNO ₃ , 40°B			(Bachelet,
(Final composition = 67.5%			Cheyman, and
Et ₂ O, 20.2% HNO ₃ , 12.3% H ₂ O)	Room	0.2*	LeBris, 1950)
1 vol. 95% alcohol + 1 vol. ether	15	1.6	(Eder, 1898)
2 vol. " " + 1 vol. "	15	2.3	(Eder, 1898)

*Gms. per 100 ml solvent.

SOLUBILITY OF SILVER NITRATE IN ANHYDROUS ORGANIC SOLVENTS

- (1) Davidson and Geer, 1933 (From the freezing pt. of known mixtures)
No compound isolated.
- (2) R. Muller, 1924
- (3) Naumann and Schier, 1914
- (4) Muller, Raschka and Wittman, 1928
- (5) Koch, 1928
- (6) Linebarger, 1895
- (7) Neumann, 1914
- (8) von Laschynski, 1894
- (9) Naumann, 1904)
- (10) de Bruyn, 1892
- (11) Welsh and Broderston, 1915
- (12) Bailey, 1930 (by the Fusion point method)
- (13) Kahlenberg and Brewer, 1908
- (14) R. Muller, 1932
- (15) Birdwhietell and Griswold, 1955
- (16) Davidson and Geer, 1938

Ag ARGENTUM

Solvent	t°	Gma. AgNO ₃ per 100 gms. Solvent	Ref.
Acetic acid	30	.1080	(16)
	30	.1047	(15)
	30	0.0776	(1)
	36	.1127	
	40	.1244	
	54	.2005	
	64	.2932	
	78	.3776	
	81	.3858	
	93	.5503	
NO Acetone	14	0.35	(8)
	18	0.44	(9)
	20	0.63	(2)
Acetonitrile	18	290.	(3)
	25	111.8	(4)
		138.2 (gms./100 cc solvent)	(2)
Acetophenone	25	0.007	(4)
iso-amyl- alcohol	25	0.54 (gma./100 cc solvent)	(2)
Aniline	18	22.0	(5)
	20	18.1	(2)
Benzene	35	0.022	(6)
	40.5	0.044	(6)
Benzonitrile	18	105.(approx.)	(7)
	20	15.4 (gms./100 cc solvent)	(2)
Ethanol	19	3.10	(10)
	20	2.11	(2)
Ethyl	20	2.69	(2)
acetate			
Ethylcyano- acetate	18	35.0	(5)
Glycol	25	49.67	(4)
Hydrazine	"ordinary"	1 (with decomp.)	(11)
Methanol	20	3.58	(2)
Methylethyl- ketone	25	0.22	(4)
Phenol	35.5	13.5	Solid Phase C ₆ H ₅ OH " " " " 63.9 (metastable) " + AgNO ₃ " + AgNO ₃ · 2C ₆ H ₅ OH AgNO ₃ + " 90.1 (metastable) AgNO ₃ · 2C ₆ H ₅ OH AgNO ₃ "
	27.2	28.4	
	11.4	46.6	
	-5.3	63.9 (metastable)	
	0.0	59.9	
	1.4	-66.2	
	7.6 m.pt.	90.1 (metastable)	
	16.0	70.9	
	30.2	76.0	
	18	75.0	
Phenylaceto- nitrile	18	75.0	(5)
Piperidine	25	4.67	(4)
Propionitrile	18	180.0	(5)
iso-Propyl alcohol	20	1.75	(2)

Ag ARGENTUM

Solvent	t°	Gms. AgNO ₃ per 100 gms. Solvent	Ref.
- further data -			
	0	30.02 (gms./100 cc solvent)	(2)
	25	45.24 (gms./100 cc solvent)	
Quinoline	25	5.58 (gms. per 100 cc solvent)	(2)
Toluidine	25	0.012	(4)

NO SOLUBILITY OF SILVER NITRATE IN LITHIUM NITRATE SOLUTIONS IN ANHYDROUS ACETIC ACID AT 30°

The results of Birdwhistell and Griswold, 1955 lie on a curve parallel to but slightly lower than those of Davidson and Geer, 1938.

Results of Birdwhistell and Griswold

moles per 1000 gms. acetic acid		moles per 1000 gms. acetic acid	
LiNO ₃	AgNO ₃	LiNO ₃	AgNO ₃
0.0	0.00617	0.03288	0.00518
0.00595	.00552	.03417	.00514
.01031	.00545	.04902	.00533
.01602	.00525	.05914	.00559
.01699	.00522	.08945	.00698
.02290	.00510		

Results of Davidson and Geer

mole %		mole %	
LiNO ₃	AgNO ₃	LiNO ₃	AgNO ₃
0.0	0.0388	1.54	0.0721
0.072	.0333	2.52	.100
.252	.0341	3.66	.136
.332	.0348	4.83	.171
.348	.0357	5.97	.200
.733	.0457	6.88	.216

SOLUBILITY OF SILVER NITRATE IN SODIUM ACETATE SOLUTIONS IN ANHYDROUS ACETIC ACID AT 30° (Birdwhistell and Griswold, 1955)

moles per 1000 gms. acetic acid		moles per 1000 gms. acetic acid	
0.0	0.00617	0.001041	0.00688
0.000259	0.00636	0.00367	0.00835
0.000735	0.00668	0.004250	0.00943

Results for the system AgNO₃ - NH₄NO₃ - Acetic Acid at various temperatures between 30 and 100° are given by Davidson and Geer, 1938. The freezing point method was used, and isotherms at 40-90° are shown graphically. The double salt AgNO₃·NH₄NO₃ appears at each temperature.

SOLUBILITY OF SILVER NITRATE IN ANHYDROUS AMMONIA AND NITRIC ACID

Solvent	t°	gms. AgNO ₃ per 100 gms. anhydrous Solvent	Reference
NH ₃	25°	86.04	(Hunt and Boncyk, 1933)
HNO ₃	?	0.2	(Jander and Wendt, 1948)

Melting Point data are given for the following:

AgNO ₃ + Cd(NO ₃) ₂	(Protsenko, 1953)	
AgNO ₃ + Cd(NO ₃) ₂ + KNO ₃	(")	
AgNO ₃ + CdCl ₂	(Bergmann, 1926)	
AgNO ₃ + CdI ₂	(")	
AgNO ₃ + CaNO ₃	(Palkin, 1928)	
AgNO ₃ + HgBr ₂	(Bergmann, 1926)	
AgNO ₃ + HgCl ₂	(")	
AgNO ₃ + HgI ₂	(")	
AgNO ₃ + LiNO ₃	(Palkin, 1926)	
AgNO ₃ + KNO ₃	(Usso, 1904; Doucet and LeDuc, 1953; Prot- senko, 1953, Palkin, 1949b)	
AgNO ₃ + NaNO ₃	(Palkin, 1949b)	
AgNO ₃ + NH ₄ NO ₃	(Flavitzki, 1909, Zawidaki, 1904)	
AgNO ₃ + Pb(NO ₃) ₂	(Glass, Laybourn and Madgri, 1932)	
AgNO ₃ + RbNO ₃	(Palkin, 1926)	
AgNO ₃ + TlNO ₃	(Van Eyk, 1905; Bokovkin, 1949; Palkin, 1949b)	
AgNO ₃ + KNO ₃ + NH ₄ NO ₃	(Bokhovkin, 1946)	
AgNO ₃ + NaNO ₃ + NH ₄ NO ₃	(Prokefev, 1941)	
AgNO ₃ + BeNO ₃ + NaNO ₃	(Kurchenkov, 1941)	
AgNO ₃ + KClO ₃	(Drozdov, 1941)	
AgNO ₃ + KNO ₃ + TlNO ₃	(Palkin, 1949)	
AgNO ₃ + NaNO ₃ + TlNO ₃	(Palkin, 1949a)	
AgNO ₃ + KNO ₃ + NaNO ₃ + TlNO ₃	(Palkin, 1949b)	

Freezing point depressions of AgNO₃ upon the addition of a large number of different salts are given by Kordes, 1950 and Kordes, Bergmann, and Vogel, 1951.

Ag ARGENTUM

O SILVER OXIDE Ag_2O

SOLUBILITY OF SILVER OXIDE IN WATER

t°	Gm. Equiv. Ag. per liter sat. sol.	Authority
18	0.000114	(Laue, 1927)
18(?)	0.000080	(Jellinek and Gordon, 1924)
19.4	0.000108	(Remy, 1925)
20	0.00012	(Laue, 1927)
20	0.00012	(Mathur and Dhar, 1931)
20	0.000185	(Whitby, 1910)
20	0.000181	(Noyes and Kohr, 1902)
20	0.00012	(Britton and Robinson, 1932)
RM.	0.00012	(Oka, 1940)
25	0.00020	(Nasanen, 1943a, 1948)
25	0.000216	(Bottger; Abegg and Cox, 1903)
25	0.000139	(Laue, 1927)
25	0.000222	(Johnston, Cuta and Garrett, 1933)
25	0.000216	(Rebierre, 1915)
25	0.000295	(")
30	0.00021	(Mathur and Dahr, 1931)
40	0.000312	(" ")
50	0.000368	(" ")
50	0.000297	(Rebierre, 1915)
50	0.000389	(")
60	0.000415	(Mathur and Dhar, 1931)
70	0.00045	(" ")
80	0.00048	(" ")

The above results, were determined by many different methods including gravimetric, calorimetric, conductometric, potentiometric and combinations of these. When plotted on cross section paper, and an average curve drawn through them, the following approximate values are obtained.

t°	Gm. Equiv. Ag. per liter	Gm. Ag_2O per liter	Gm. Equiv. Ag. per liter	Gm. Ag_2O per liter
10	0.00006	0.007	40	0.00030
15	0.00010	0.0116	50	0.00036
20	0.00015	0.0174	60	0.00041
25	0.00019	0.022	70	0.00045
30	0.00023	0.027	80	0.00048
				0.055

Tourky and El Wakkad bubbled nitrogen through silver oxide suspended in water, and found that the particles approached a minimum in size and hence a maximum in solubility. The maximum silver ion activity in the solution was found to be 1.15×10^{-4} gm. moles per liter.

SOLUBILITY OF SILVER OXIDE IN SOLUTIONS OF SODIUM, POTASSIUM AND BARIUM HYDROXIDES AT 25°

The results of Johnston, Cuts and Garrett, 1933 for aqueous NaOH, KOH and Ba(OH)₂ solutions show that, within experimental error, the solubility of Ag₂O is identical in equivalent concentrations of OH⁻. The solubility passes through a minimum of 0.06.10⁻⁴ gm. equivalents of Ag₂O per liter at approximately 0.015 normal alkali. These authors also give results showing that in alkaline solutions, Ba(NO₃)₂, KNO₃, and K₂SO₄, do not appreciably influence the solubility of Ag₂O.

Results of:

(Johnston, Cuta and Garrett,
1933)

Normality of Aq. OH ⁻	Gm. Equiv. Ag ₂ O per liter x 10 ⁻⁴
0.0012	0.329
0.010	0.076
0.020	0.062
0.05	0.110
0.117	0.26
0.40	0.73
1.17	2.00
2.33	3.7
6.6	5.4

Results of:

(Mathur and Dhar, 1931)

Normality of Aq. NaOH	Gm. Ag ₂ O per liter	Gm. Equiv. Ag ₂ O per liter x 10 ⁻⁴
0.0002	0.0093	0.87
0.001	0.0016	0.15
0.01	0.0010	0.10
0.10	0.0032	0.30
0.506	0.0098	0.91
1.03	0.0162	1.50
2.26	0.0309	2.86
5.20	0.0457	4.23

SOLUBILITY OF SILVER OXIDE IN AQUEOUS SOLUTIONS OF AMMONIA

The results of Olmer, 1924 (in which saturation was obtained by agitation for two hours at room temperature and allowing the solution to stand for 24 hours) are in excellent agreement with those of Whitney and Melcher, 1903 at 25°. The data of Randall and Halford, 1930 at 25° are lower.

Data of Olmer, 1924 (Room T°)
and Whitney and Melcher (25°)(*)
moles per liter moles per liter
sat. sol. sat. sol.

NH ₃	Ag ⁺	NH ₃	Ag ⁺
0.220	0.0658*	1.498	0.454*
0.294	0.088	1.522	0.470*
0.469	0.134*	1.765	0.625
0.588	0.181	2.059	0.585
0.684	0.205*	2.353	0.710
0.733	0.224*	2.941	0.848
0.876	0.257*	3.521	0.986
0.882	0.258	4.049	1.092
0.915	0.276*	4.056	1.191
1.147	0.343*	5.001	1.304
1.176	0.355	5.469	1.363
1.471	0.456	5.76	1.369

Data of Randall and Halford, 1930
moles per liter moles per liter
sat. sol. sat. sol.

NH ₃	Ag ⁺	NH ₃	Ag ⁺
0.05302	0.01155	0.3200	0.07535
0.05532	0.01282	0.3540	0.07787
0.05821	0.01338	0.0519	0.1525
0.06173	0.01406	0.6707	0.1582
0.1479	0.03499	0.8673	0.2033
0.1575	0.03606	0.9518	0.2225
0.2456	0.05787	1.2304	0.2888
0.3155	0.07352		

Ag ARGENTUM

SOLUBILITY OF SILVER OXIDE IN AQUEOUS SOLUTIONS OF METHYLAMINE
AND ETHYLAMINE

In aq. methylamine (Olmer, 1924 at room temp. Euler, 1903 at 18°) moles per liter				In aq. ethylamine (Euler, 1903 at 18°) moles per liter	
CH ₃ NH ₂	Ag ⁺	CH ₃ NH ₂	Ag ⁺	C ₂ H ₅ NH ₂	Ag ⁺
0.100	0.0322(E.)	3.279	0.731	0.100	0.0322
0.440	0.104	3.556	0.759	0.50	0.160
0.50	0.160(E.)	5.716	0.954	1.00	0.314
1.00	0.314(E.)	8.230	0.885		
1.412	0.340	9.333	0.658		
2.095	0.504				

SOLUBILITY OF SILVER OXIDE IN AQUEOUS GLYCINE AND SODIUM
GLYCINATE SOLUTIONS AT 30°
(DuBois, 1949)

In aq. glycine		In aq. sodium glycinate	
moles glycine per liter	moles AgOH per liter	moles Na glycinate per liter	moles AgOH per liter
1.00	0.0501	0.25	0.0614
0.50	.0389	.10	.0258
.25	.0335	.05	.0128
.10	.0274	.02	.0054

SOLUBILITY OF SILVER OXIDE IN MIXTURES OF WATER AND ALCOHOL AT 25°
(Kloeky and Woo, 1926)

Carefully purified materials were used. Saturation was secured by constant stirring for 10 hours. The dissolved Ag₂O was determined by adding a small amount of 0.1 N KCl and measuring the turbidity produced, against known standards.

Wt.% C ₂ H ₅ OH in solvent	Gms. Ag ₂ O per liter sat. sol.	Wt.% C ₂ H ₅ OH in solvent	Gms. Ag ₂ O per liter sat. sol.
0.0	0.0262	45.70	0.0174
10.95	0.0197	64.00	0.0145
22.92	0.0181	77.00	0.0120
34.30	0.0176	91.50	0.0091

Tananaev and Lovi (1942) found the equilibrium constant of the reaction $2\text{Ag}^+ + \text{Mg}(\text{OH})_2 \rightleftharpoons 2\text{Ag}(\text{OH}) + \text{Mg}^{++}$ to be $K = 2.5 \times 10^4$

Faivre (1940) heated silver oxide and found a maximum solubility of Ag in Ag₂O of 4%.

Markin (1944, 1946) reports the conductivities in the systems Ag₂O - K₂O - B₂O₃, and Ag₂O - Na₂O - B₂O₃.

SILVER PHOSPHATE Ag_3PO_4

PO

SOLUBILITY IN WATER

One liter of water dissolves 0.00644 gm. of Ag_3PO_4 at 20°. (Böttger, 1903).

Solubility product constant determinations:

On the basis of a study of the reactions $\text{Ag}_3\text{PO}_4 \rightleftharpoons 3\text{AgCl}$ ($K = 1.25 \times 10^9$) and $\text{MgNH}_4\text{PO}_4 \rightleftharpoons \text{Ag}_3\text{PO}_4$ ($K = 1.75 \times 10^8$) at room temperature. Tananaev and Lovi (1942) found the solubility product of silver phosphate to be 1.46×10^{-21} at room temperature. At 18-20°, Zharovskii (1951) found 1.3×10^{-20} .

THE SYSTEM SODIUM OXIDE - PHOSPHORUS PENTOXIDE - WATER AT 25°
(Flatt and Grunisholz, 1951)

gms. per 100 gms. sat. sol.			gms. per 100 gms. sat. sol.		
Ag_2O	P_2O_5	Solid Phase	Ag_2O	P_2O_5	Solid Phase
0.0648	0.0424 ^a	Ag_3PO_4	12.42	40.14	Ag_2HPO_4
.123	.0834 ^a	"	13.34	41.38	"
.248	.196 ^a	"	15.10	43.24	"
.349	.315 ^a	"	16.17	44.13	"
.638	.852 ^a	"	17.92	45.21	"
1.00	1.98	"	19.41	45.99	"
1.47	3.71	"	19.65	45.90	$\text{Ag}_2\text{HPO}_4 + \text{AgH}_2\text{PO}_4$
1.94	5.76	"	20.45	46.17*	Ag_2HPO_4
2.84	9.80	"	24.97	47.24*	"
3.81	13.93	"	19.43	46.30	AgH_2PO_4
4.18	15.42	"	18.43	47.90	"
5.32	19.56	"	17.71	50.86	"
6.09	22.37	"	17.63	51.97	"
6.81	24.60	"	17.72	52.88	"
7.40	26.10	"	17.87	53.37	"
7.97	27.54	$\text{Ag}_3\text{PO}_4 + \text{Ag}_2\text{HPO}_4$	18.84	54.89	"
8.49	29.44	Ag_2HPO_4	19.99	55.39	"
9.61	33.25	"	24.66	55.60	"
10.51	35.91	"	15.24	61.63	H_3PO_4

*metaatable

^arecalculated in terms of Ag_3PO_4 and H_3PO_4 , these data are:

wt. % H_3PO_4 :	0.0402	0.0806	0.201	0.336	1.001
wt. % Ag_3PO_4 :	0.0794	0.147	0.300	0.419	0.766

The solubility of silver phosphate in 0.0001 to 1.0 M HNO_3 solutions was determined by Tananaev, Chrelashvili, and Sheliya, 1940. The concentration K_{sp} is 3×10^{-16} .

Ag ARGENTUM

SOLUBILITY OF SILVER PHOSPHATE IN AQUEOUS AMMONIA SOLUTIONS AT 35.5° (Saraswat, 1949)

mmol NH ₃ per liter solvent	mmol Ag ₃ PO ₄ per liter sat. sol.	mmol NH ₃ per liter solvent	mmol Ag ₃ PO ₄ per liter sat. sol.
4.05	0.133	64.72	2.057
8.09	0.265	129.45	4.113
16.18	0.531	258.9	8.292
32.36	1.061	517.8	26.478

SOLUBILITY OF SILVER PHOSPHATE IN AQUEOUS SALT SOLUTIONS AT 25° (Talipov and Obel'chenko, 1953, 1953a)

Salt	moles salt per liter	Concentration solubility product of Ag ₃ PO ₄
Na ₂ HPO ₄	10 ⁻⁵	1.83 x 10 ⁻¹⁶
	0.829	1.21 x 10 ⁻¹³
K ₂ HPO ₄	10 ⁻⁵	1.83 x 10 ⁻¹⁶
	4.5	1.17 x 10 ⁻¹²
Na ₂ SO ₄	Saturated	4 x (1.83 x 10 ⁻¹⁶)
K ₂ SO ₄	Saturated	6 x (1.83 x 10 ⁻¹⁶)

PO SILVER PYROPHOSPHATE Ag₄P₂O₇

At 26°, 100 ml of a solution saturated with both Ag₄P₂O₇ and Na₄P₂O₇ contains 0.03134 gms. Ag₄P₂O₇. It is about twice as soluble as this in a K₄P₂O₇ solution. (Kobn, 1953.)

ReO SILVER PERRHENATE AgReO₄

One liter of water dissolves 3.2 gms. AgReO₄ at 20°, as determined by conductivity measurements. (Noddack, 1929.)

SILVER Diamine PERRHENATE [Ag(NH₃)₂] ReO₄

One liter of ammonia of d = 0.930 dissolve 16.18 gms. Ag(NH₃)₂ ReO₄ at 20°. (Wilke-Dorfurt and Gunzert, 1933.)

SOLUBILITY OF SILVER SULFIDE IN WATER

Critical reviews of the published determinations of the solubility of metal sulfides in water are given by Kolthoff, 1931, and by Ravitz, 1936. Kolthoff calls attention to the incorrectness of the results of Weigel, 1907, and recommends that his results be omitted from reliable tables of solubility data. He gives an improved list of solubilities and solubility products but made no attempt to correct for activities. Ravitz made a careful study of the results of previous investigators and recalculated their results with the aid of recent activity data. His preferred value for silver sulfide at 10° is - One liter sat. solution in water contains 4.29×10^{-16} gm. mols. Ag_2S . The solubility product is 1.04×10^{-54} . At 25° , one liter sat. solution in water contains 2.48×10^{-15} gm. mols. Ag_2S . The solubility product is 3.28×10^{-52} .

Coates, Cole, Gray and Faux (1951) found a thermodynamic K_{sp} of 6.2×10^{-52} from EMF measurements on the cell $\text{Ag}, \text{Ag}_2\text{S}|\text{H}_2\text{S}|\text{HCl}|\text{H}_2, \text{Pt}$.

Kapustinsky (1940) calculated the solubility product of silver and other metal sulfides in water from free energy data. His value at 25° is 5.9×10^{-52} and agrees well with those found by other investigators. He then calculates the solubility of Ag_2S in solutions of different acidity (25°):

pH	3	5	7	9	11
gm. mols per liter:	1.4×10^{-12}	6.5×10^{-14}	3.8×10^{-15}	6.6×10^{-16}	3.1×10^{-18}

Ag ARGENTUM

SOLUBILITY OF SILVER SULFIDE AT 20° (Treadwell and Hepenstrick, 1949a)

pH	Composition of solution (moles per liter)				Total dissolved Ag ⁺ gm. atoms per liter
	NaClO ₄	HClO ₄	H ₂ S	NaOH	
1.0	...	0.100	0.1	...	1.96 x 10 ⁻⁶
2.0	0.090	.010	.1	...	1.00 x 10 ⁻⁶
3.00	.099	.001	.1	...	1.17 x 10 ⁻⁶
4.5	.10	...	.1	0.0005	1.45 x 10 ⁻⁶
5.65	.10	...	.1	.005	8.14 x 10 ⁻⁶
6.0	.10	...	.1	.01	11.90 x 10 ⁻⁶
7.0	.10	...	.1	.02	26.52 x 10 ⁻⁶

Melting point determinations are reported for the following:

Ag ₂ S + Cu ₂ S	(Schwarz and Romero, 1927; Suhr, 1955)
Ag ₂ S + Cu ₂ S + PbS	" "
Ag ₂ S + PbS	" "
Ag ₂ S + SiS ₂	(Camhi, 1912)
Ag ₂ S + Ti ₂ S	(Huber, 1921)
Ag ₂ S + ZnS	(Friedrich, 1908)
Ag ₂ S + Sb ₂ S ₃	(Jensen, 1947)

30 SILVER SULFATE Ag₂SO₄

SOLUBILITY IN WATER

Data of Barre (1911), except as indicated. The value at 25° is the average of Hill and Simmons, 1909 (0.831), Swan, 1899 (0.837), Harkins, 1911 (0.830), Chloupek and Danes, 1932 (0.832), Akerlof and Thomas, 1934 (0.828), Davis, Ricci and Sauter, 1939 (0.839), Simons and Ricci, 1946 (0.833), Addlestone, Marsh and Hall, 1940 (0.841)

t°	Gms. Ag ₂ SO ₄ per 100 gms. sat. sol.	t°	Gms. Ag ₂ SO ₄ per 100 gms. sat. sol.	t°	Gms. Ag ₂ SO ₄ per 100 gms. sat. sol.
0	0.57 (0.549)†	35	0.929 (0.933)*	80	1.28
10	0.69	40	0.97	90	1.34
20	0.79 (0.783)*	45	1.022†	100	1.39
25	0.834 ± 0.003	50	1.05	150	1.4**
30	0.88	60	1.14	200	1.1**
		70	1.21	250	0.6**

*Simona and Ricci, 1946

**Lietzke and Stoughton, 1956

†Addlestone, Mareh, and Hall, 1940

30

SOLUBILITY OF SILVER SULFATE IN SULFURIC ACID SOLUTIONS

(Akerlof and Thomas, 1934)

t°	Solvent: moles H ₂ SO ₄ per 1000 gms. H ₂ O	moles Ag ₂ SO ₄ per 1000 gms. sat. sol.	Solvent: moles H ₂ SO ₄ per 1000 gms. H ₂ O	moles Ag ₂ SO ₄ per 1000 gms. sat. sol.
25°	0.6050	0.02615	1.250	0.03481
	0.1000	0.02919	1.500	0.03522
	0.2510	0.03115	1.750	0.03428
	0.5000	0.03315	2.0000	0.03376
	0.7500	0.03416	2.500	0.03269
	1.000	0.03468	2.973	0.03092

(Data of Swan, 1899)

t°	moles H ₂ SO ₄ per liter solvent	moles Ag ₂ SO ₄ per liter sat. sol.
25°	0.0	0.0269
	.01451	.0274
	.02901	.0278
	.05263	.0284

The data of Drucker (1901) are somewhat lower than the above.
Akerlof and Thomas also give data for solutions containing H₂SO₄ + MgSO₄.

Ag ARGENTUM

THE SYSTEM SILVER SULFATE-SULFURIC ACID-WATER AT 25° (Simons and Ricci, 1946a)

	Gms. Ag ₂ SO ₄ per 100 gms. sat. sol.	Gms. H ₂ SO ₄ per 100 gms. sat. sol.	Solid Phase	Gms. Ag ₂ SO ₄ per 100 gms. sat. sol.	Gms. H ₂ SO ₄ per 100 gms. sat. sol.	Solid Phase
30	0.833	0.0	Ag ₂ SO ₄	6.58	74.95	β - AgHSO ₄
	.990	4.75	"	6.54	75.13	"
	.946	11.34	"	6.57	75.93	"
	.618	21.13	"	7.14	77.9	"
	.411	38.12	"	7.97	79.73	"
	.400	54.30	"	9.13	80.78	"
	.632	62.15	"	9.42	80.92	"
	.831	64.97	"	10.85	81.27	"
	1.897	70.86	"	11.39	81.21	"
	2.273	71.87	"	12.70	80.89	"
	2.84	72.60	"	13.58	80.57	"
	2.94	72.68	"	5.58	75.43	α - AgHSO ₄
	3.89	73.66	"	4.94	76.78	"
	4.06	73.78	"	4.34	80.27	"
	4.50	74.03	"	4.51	81.59	"
	4.74	74.26	"	4.79	82.22	"
	5.50	74.26	"	6.13	82.68	"
	5.63	74.19	"	7.94	83.01	"
	6.57	74.21	Ag ₂ SO ₄ + β - AgHSO ₄	12.81	81.62	"
	6.55	74.47	"	*19.45	77.86	α or β - AgHSO ₄ (?)
	6.61	74.25	"	*19.82	77.64	"
	6.59	74.31	"	*20.81	76.98	"
	6.52	74.5	"	*21.01	76.41	"
Av6.57	74.35	"	"	*21.45	76.32	"
6.18	74.30	Ag ₂ SO ₄ + β - AgHSO ₄	*21.50	76.55	"	"
6.23	74.08	"	*21.82	76.17	"	"
6.32	74.31	"				
6.32	73.95	"				
6.27	74.07	"				
Av6.26	74.14	"				

*Solubility curves of α and β - AgHSO₄ indistinguishably close.

Lietzke and Stoughton, 1956

- moles Ag₂SO₄ per 1000 gms. H₂O -

t°	moles H ₂ SO ₄ per 1000 gms. H ₂ O :	0.1	0.5 ₁₁	1.0
100°		0.074	0.102	0.123
150°		.100	.180	.292
200°		.118	.258	.511
250°		.136	.317	.678

SOLUBILITY OF SILVER SULFATE IN AQUEOUS NITRIC ACID AT 25°
(Hill and Simmons, 1909)

Normality of Aq. HNO ₃	Per cent Conc. of Aq. HNO ₃	d ₂₅ of Sat. Sol.	Gms. Ag ₂ SO ₄ per liter	
0	0	1.0054	8.35	
1.0046	6.154	1.061	34.086	
2.0452	12.005	1.1069	49.010	
4.017	22.37	1.1871	71.166	
4.209	23.33	1.1956	73.212	
5.564	29.84	1.2456	84.609	
8.487	42.37	1.3326	94.671	
10.034	48.77	1.3676	90.806	30

The data of Swan, 1899 do not agree with those above:

Normality of HNO ₃ in solvent	0.0	0.01589	0.03178	0.06357
Gms. Ag ₂ SO ₄ per liter sat. sol.	8.41	9.33	10.18	11.83

SOLUBILITY OF SILVER SULFATE IN AMMONIA SOLUTIONS WITH
AMMONIUM SULFATE ADDED AT 25°
(Vosburgh and McClure, 1948)

gms. per 1000 gms. H ₂ O			gms. per 1000 gms. H ₂ O		
NH ₃	(NH ₄) ₂ SO ₄	Ag ₂ SO ₄	NH ₃	(NH ₄) ₂ SO ₄	Ag ₂ SO ₄
16.01	3.330	17.680	35.25	3.322	20.062
31.08	3.987	19.420	45.18	3.321	21.098
33.50	3.326	19.763	59.04	3.322	22.557

SOLUBILITY OF SILVER SULFATE IN SILVER NITRATE SOLUTIONS AT 25°
(Harkins, 1911)

Saturated solution:			
moles AgNO ₃ per liter	0.02496	0.04986	0.09961
gms. Ag ₂ SO ₄ per liter	6.095	4.487	2.644
density ₂₅	1.0065	1.0084	1.0137

THE SYSTEM SILVER SULFATE - SILVER ACETATE - WATER AT 17°
(Euler, 1904)

gms. per liter		density Sat. Sol.	Solid Phase
Ag ₂ SO ₄	CH ₃ COOAg		
3.95	8.30	1.0094	Ag ₂ SO ₄ + CH ₃ COOAg

Ag ARGENTUM

THE SYSTEM SILVER SULFATE - ALUMINUM SULFATE - H₂O (Addlestone, Marsh, and Hall, 1940; Caven and Mitchell, 1925a (30°))

No evidence of a silver alum was found.

gms. per 1000 gms. H₂O

Ag₂SO₄

Al₂(SO₄)₃

Solid Phase

Results at 0°

5.52

0.0

Ag₂SO₄

5.58

28.33

"

5.77

57.27

"

6.39

85.74

"

6.58

112.69

"

6.58

179.44

"

6.64

203.8

"

6.80

290.4

Ag₂SO₄ + Al₂(SO₄)₃·18H₂O

0.0

340.0

Al₂(SO₄)₃·18H₂O

Results at 25°

8.48

0.0

Ag₂SO₄

8.64

37.12

"

9.01

100.8

"

9.04

131.9

"

9.48

175.9

"

9.57

207.6

"

9.64

293.0

"

9.67

358.2

"

9.70

376.0

Ag₂SO₄ + Al₂(SO₄)₃·18H₂O

5.27

382.1

Al₂(SO₄)₃·18H₂O

0.0

395.8

"

Results at 45°

10.38

0.0

Ag₂SO₄

10.94

32.88

"

11.72

65.38

"

12.04

122.7

"

12.38

190.5

"

12.44

252.6

"

12.54

439.3

Ag₂SO₄ + Al₂(SO₄)₃·18H₂O

0.0

467.0

Al₂(SO₄)₃·18H₂O

Results at 30° (C. & M.)

Moles per 1000 gms. H₂O

0.0285

0.0

Ag₂SO₄

0.0292

0.0777

"

0.0304

0.1449

"

0.0306

0.3026

"

0.0306

0.5114

"

0.0308

0.8153

"

0.0310

0.9210

"

0.0314

1.276

Ag₂SO₄ + Al₂(SO₄)₃·18H₂O

0.0

1.187

Al₂(SO₄)₃·18H₂O

Data for the solubility of Ag_2SO_4 in solutions containing $\text{Al}_2(\text{SO}_4)_3$ + ZnSO_4 are given by Akerlof and Thomas, 1934.

THE SYSTEM SILVER SULFATE - BERYLLIUM SULFATE - WATER AT 35°
(Orlick and Simons, 1951)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ag_2SO_4	BeSO_4		Ag_2SO_4	BeSO_4	
0.929	0.0	Ag_2SO_4	0.792	22.25	Ag_2SO_4
.892	2.48	"	.661	27.31	"
.935	6.17	"	.599	29.93	$\text{Ag}_2\text{SO}_4 + \text{BeSO}_4 \cdot 4\text{H}_2\text{O}$
.945	11.05	"	.247	30.02	$\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$
.900	16.95	"	0.0	30.15	"

S0

THE SYSTEM SILVER SULFATE - CESIUM SULFATE - WATER
(Von Dohlen and Simons, 1951)

Results at 25°

gms. per 100 gms. sat. sol.		den- sity Sat. Sol.	Solid Phase	gms. per 100 gms. sat. sol.		den- sity Sat. Sol.	Solid Phase
Ag_2SO_4	Cs_2SO_4			Ag_2SO_4	Cs_2SO_4		
0.76	5.93	1.055	A	1.43	48.11	1.635	A
.86	13.94	1.136	A	1.43	51.99	1.743	A
.98	20.52	1.211	A	1.53	57.94	1.871	A
1.07	27.53	1.306	A	1.57	62.74	2.005	A
1.19	35.16	1.411	A	1.57	62.99	2.011	A
1.22	36.19	1.420	A	1.57	63.76	2.049	A + C
1.28	41.19	1.514	A	0.57	64.21	2.016	C
1.38	46.96	1.623	A	0.0	64.53	2.007	C

Results at 35°

1.80 64.27 2.058 A + C

A = Ag_2SO_4

C = Cs_2SO_4

SOLUBILITY OF SILVER SULFATE IN COPPER SULFATE SOLUTIONS AT 25°
(Akerlof and Thomas, 1934)

Solvent: moles CuSO_4 per 1000 gms. H_2O	moles Ag_2SO_4 per 1000 gms. Sat. Sol.	Solvent: moles CuSO_4 per 1000 gms. H_2O	moles Ag_2SO_4 per 1000 gms. Sat. Sol.
0.1061	0.02587	0.6789	0.03314
0.2160	0.02711	0.8224	0.03482
0.3262	0.02856	0.9426	0.03613
0.4465	0.03018	1.097	0.03770
0.5634	0.03170	1.235	0.03899

Ag ARGENTUM

THE SYSTEM SILVER SULFATE - POTASSIUM SULFATE - WATER

(Data of Barre, 1911 at 14.5°)

gms. per 100	{	K ₂ SO ₄	3.20	5.65	8.32	9.30
gms. Sat. Sol.		Ag ₂ SO ₄	0.661	0.733	0.816	0.851

(Data of Simons and Ricci, 1946 at 25°)

50	gms. per 100 gms. Sat. Sol.		density Sat. Sol.	Solid Phase
	K ₂ SO ₄	Ag ₂ SO ₄		
	0.0	0.833	1.004	Ag ₂ SO ₄
	3.86	0.79	1.033	"
	7.29	0.905	1.067	"
	9.72	0.991	1.084	"
	10.25	1.009	1.090	"
	10.93	1.04	1.098	Ag ₂ SO ₄ + K ₂ SO ₄
	10.89	0.885	1.094	K ₂ SO ₄
	10.82	0.568	1.089	"
	10.80	0.0	1.084	"

SOLUBILITY OF SILVER SULFATE IN POTASSIUM SULFATE SOLUTIONS AT 25° (Chloupek and Danes, 1932, Harkins, 1911, Swan, 1899)

The results of Drucker, 1901 are somewhat lower than these

moles K ₂ SO ₄ per liter solvent	moles Ag ₂ SO ₄ per liter sat. sol.	density sat. sol.
0.0100	0.02576	.... (C.D.)
.01251	.0252	1.0064 (H.)
.01359	.0253	.... (S.)
.0200	.02502	.... (C.D.)
.02502	.0245	1.0079 (H.)
.02717	.0245	.... (S.)
.0500	.02422	.... (C.D.)
	.0238)	1.0112 (H.)
.1000	.0238	1.0180 (H.)
.200	.02586	.... (C.D.)
.500	.03266	.... (C.D.)
Sat.	.03737	.... (C.D.)

33° to 100° (Barre, 1911)	Results at 33°		Results at 51°		Results at 75°		Results at 100°	
	Gms. per 100 Gms.		Gms. per 100 Gms.		Gms. per 100 Gms.		Gms. per 100 Gms.	
	Sat. Sol.		Sat. Sol.		Sat. Sol.		Sat. Sol.	
	K ₂ SO ₄	Ag ₂ SO ₄	K ₂ SO ₄	Ag ₂ SO ₄	K ₂ SO ₄	Ag ₂ SO ₄	K ₂ SO ₄	Ag ₂ SO ₄
	3.22	0.863	3.20	1.023	3.12	1.273	3.23	1.488
	5.62	0.940	5.61	1.127	5.73	1.406	5.60	1.675
	8.37	1.046	8.40	1.247	8.43	1.554	8.45	1.890
	10.41	1.117	10.55	1.340	10.55	1.665	11.30	2.115
	11.80	1.177	13.16	1.450	13.17	1.806	15.07	2.410
			14.37	1.524	17.06	2.021	18.58	2.677

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SOLUBILITY OF SILVER SULFATE IN POTASSIUM BISULFATE SOLUTIONS AT 25°
(Svan, 1899)

Equiv. KHSO ₄ per liter solvent.	0.05264	0.10526
gms. Ag ₂ SO ₄ per liter sat. sol.	8.13	8.07

THE SYSTEM SILVER SULFATE - LITHIUM SULFATE - WATER AT 25°
(Simons and Ricci, 1946)

gms. per 100 gms. sat. sol.		den- sity sat. sol.	Solid Phase	gms. per 100 gms. sat. sol.		den- sity sat. sol.	Solid Phase
Li ₂ SO ₄	Ag ₂ SO ₄			Li ₂ SO ₄	Ag ₂ SO ₄		
0.0	0.833	1.004	Ag ₂ SO ₄	25.32	.951	1.231	Ag ₂ SO ₄ + Li ₂ SO ₄
5.57	.786	1.046	"	25.40	.502	1.223	Li ₂ SO ₄
11.02	.89	1.102	"	25.53	0.0	1.215	"
16.34	.95	1.151	"				
22.04	.963	1.199	"				

Data for the solubility of Ag₂SO₄ in solutions containing Li₂SO₄ + MgSO₄ at 25° are given by Akerlof and Thomas 1934.

SOLUBILITY OF SILVER SULFATE IN MAGNESIUM SULFATE SOLUTIONS

Results at 25°

Data of Akerlof and Thomas, 1934

Solvent:	Moles	Solvent:	Moles
Moles	Ag ₂ SO ₄	Moles	Ag ₂ SO ₄
MgSO ₄	per 1000	MgSO ₄	per 1000
per 1000	gms.	per 1000	gms.
gms. H ₂ O	sat. sol.	gms. H ₂ O	sat. sol.
0.1237	0.02488	1.143	0.03335
0.3017	0.02636	1.348	0.03442
0.4011	0.02789	1.545	0.03525
0.6266	0.02948	1.718	0.03569
0.7986	0.03093	1.973	0.03618
0.9711	0.03222		

Data of Harkins, 1911

Gm.	d ₂₅	Gms.
Equiv.	of	Ag ₂ SO ₄
MgSO ₄	Sat.	per liter
per liter	Sol.	
0.020022	1.0061	8.140
0.050069	1.0079	7.941
0.10004	1.0105	7.740
0.20005	1.0164	7.733

Ag ARGENTUM

Akerlof and Thomas (1934) also give data for mixtures of $\text{MgSO}_4 + \text{H}_2\text{SO}_4$, $\text{MgSO}_4 + \text{CdSO}_4$ and $\text{MgSO}_4 + \text{Li}_2\text{SO}_4$.

Results at 35°

(Orlick and Simons, 1951)

	gms. per 100 gms. sat. sol.		Solid Phase	gms. per 100 gms. sat. sol.		Solid Phase
	Ag_2SO_4	MgSO_4		Ag_2SO_4	MgSO_4	
30	0.929	0.0	Ag_2SO_4	1.052	18.63	Ag_2SO_4
	0.906	0.320	"	0.99	24.06	"
	0.952	5.44	"	0.840	29.33	" + $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
	1.050	11.64	"	0.633	29.35	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
	1.065	14.50	"	0.0	29.77	"

SOLUBILITY OF SILVER SULFATE IN SOLUTIONS OF AMMONIUM SULFATE

(Barre, 1911 at 16.5°, 33°, 51°, 75°, 100°;

Chloupek and Danes, 1932 at 25°;

Simons and Ricci, 1946 at 25°)

Results at 25°

Results at 16.5°		(C.&D.)						(S.&R.)		
		Mols. $(\text{NH}_4)_2\text{SO}_4$ per liter aq. solvent		Mols. Ag_2SO_4 per 1000 gms. sat. sol.		gms. per 100 gms. sat. sol.		Den- sity Sat. Sol.	Solid Phase	
$(\text{NH}_4)_2\text{SO}_4$	Ag_2SO_4					Ag_2SO_4	$(\text{NH}_4)_2\text{SO}_4$			
8.96	0.889	0.01	0.025810	0.833	0.0	1.004	A			
16.24	1.089	0.02	0.025083	.90	5.95	1.034	A			
22.30	1.217	0.05	0.024269	1.08	11.88	1.074	A			
27.65	1.273	0.10	0.024315	1.311	20.58	1.128	A			
32.02	1.298	0.20	0.025642	1.428	28.93	1.176	A			
35.55	1.290	0.50	0.03092	1.453	34.48	1.208	A			
39.47	1.252	1.00	0.03950	1.441	37.75	1.229	A			
41.62	1.222			1.414	40.67	1.243	A			
				1.383	42.91	1.254	A + N			
				0.740	43.18	1.246	N			
				0.0	43.45	1.233	N			

A = Ag_2SO_4

N = $(\text{NH}_4)_2\text{SO}_4$

Results at 33°		Results at 51°		Results at 75°		Results at 100°	
Gms. per 100		Gms. per 100		Gms. per 100		Gms. per 100	
Gms. Sat. Sol.		Gms. Sat. Sol.		Gms. Sat. Sol.		Gms. Sat. Sol.	
(NH ₄) ₂ SO ₄ Ag ₂ SO ₄		(NH ₄) ₂ SO ₄ Ag ₂ SO ₄		(NH ₄) ₂ SO ₄ Ag ₂ SO ₄		(NH ₄) ₂ SO ₄ Ag ₂ SO ₄	
8.85	1.101	8.90	1.362	8.80	1.758	9.23	2.221
15.90	1.331	16.27	1.680	15.23	2.155	15.00	2.626
22.22	1.500	22.43	1.887	22.30	2.490	22.01	3.075
27.25	1.585	32.10	2.061	28.25	2.734	27.00	3.325
30.80	1.619	35.38	2.095	32.00	2.823	34.90	3.663
35.88	1.627	39.03	2.082	35.82	2.889	38.70	3.772
39.46	1.600	42.37	2.055	41.16	2.929	44.15	3.854
43.22	1.557	45.05	2.026	46.46	2.902	47.63	3.867

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THE SYSTEM SILVER SULFATE - SODIUM SULFATE - WATER

(Barre, 1910, 1911 at 14.5° (graphically), 18°, 33°, 51°, 75°, 100°;
 Simons and Rice, 1946 at 20°, 25°, 31.5°, 35°)

Results at 18°

gms. per 100— gms. H ₂ O		Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄	
0.0	0.766	A
0.25	.712	SS
0.51	.682	SS
0.74	.675	SS
1.00	.665	SS
1.48	.670	SS
2.01	.673	SS
2.50	.689	SS
3.04	.703	SS
4.00	.736	SS
4.99	.768	SS
10.10	.932	SS
13.04	1.028	SS

Results at 20°

gms. per 100 gms. Sat. Sol.		Wt. % Ag ₂ SO ₄ in anhyd. S.S.*	Den- sity Sat. Sol.	Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄			
0.0	0.783	...	1.004	A
0.500	.691	100.2	1.010	SS
1.044	.673	99.9	1.013	SS
2.07	.682	99.8	1.022	SS
3.15	.704	99.8	1.032	SS
4.19	.731	99.0	1.040	SS
5.33	.771	97.9	1.051	SS
7.77	.836	97.8	1.075	SS
10.72	.919	96.5	1.105	SS
12.92	.971	95.4	1.127	SS
15.51	1.015	95.3	1.154	SS
15.92	1.026	94.9	1.156	SS
16.11	1.030		1.160	SS + N10
16.11	1.066†		1.161	N10
16.09	0.570		1.157	N10
15.89	0.0		1.147	N10

A = Ag₂SO₄

SS = Solid Solution

N10 = Na₂SO₄·10H₂O

* by algebraic extrapolation.

† metastable

Ag ARGENTUM

The System Silver Sulfate - Sodium Sulfate - Water (Cont.)

Results at 25°						Results at 31.5°					
gms. per 100 gms. sat. sol.		Wt. % Ag ₂ SO ₄ in anhyd. SS*	Density Sat. Sol.	Solid Phase		gms. per 100 gms. sta. sol.		Wt. % Ag ₂ SO ₄ in anhyd. S.S.*	Density Sat. Sol.	Solid Phase	
Na ₂ SO ₄	Ag ₂ SO ₄	SS*	Sol.			Na ₂ SO ₄	Ag ₂ SO ₄	S.S.*	Sol.		
0.0	0.833	...	1.004	A		0.0	0.899	...	1.002	A	
0.507	.744	100.2	1.009	SS		0.503	.814	99.9	1.009	SS	
1.016	.722	99.7	1.013	SS		1.066	.790	99.9	1.011	SS	
2.07	.733	99.6	1.020	SS		1.548	.794	99.8	1.019	SS	
3.09	.756	99.2	1.031	SS		2.609	.813	99.5	1.029	SS	
4.14	.786	98.6	1.040	SS		2.74	.820	99.1	1.030	SS	
5.42	.831	99.8	1.054	SS		3.615	.842	99.0	1.035	SS	
5.88	.844	98.7	1.053	SS		5.168	.887	98.9	1.049	SS	
7.80	.893	98.6	1.073	SS		11.40	1.062	96.2	1.112	SS	
10.63	.983	95.6	1.106	SS		15.36	1.154	93.6	1.148	SS	
12.89	1.02	95.6	1.126	SS		20.45	1.181	88.1	1.203	SS	
15.88	1.079	93.4	1.159	SS		25.18	1.118	79.0	1.252	SS	
17.40	1.101	92.2	1.170	SS		27.45	1.034	70.3	1.276	SS	
18.62	1.115	90.7	1.185	SS		29.46	0.919	62.3	1.297	SS	
20.44	1.121	90.3	1.202	SS		30.15	.858	55.0	...	SS	
20.83	1.118	89.7	1.206	SS		30.92	.772	46.7	1.304	SS	
21.37	1.120	88.4	...	SS		31.23	.731	43.2	1.308	SS	
21.78	1.113	86.8	1.218	SS		31.35	.705	37.7	1.309	SS	
21.80	1.114		1.217	SS + N10		31.53	.656	36.1	1.313	SS	
21.80	0.836		1.214	N10		31.57	.656		1.314	SS + N10	
21.75	0.316		1.206	N10		31.58	.588		1.310	N10	
21.64	0.0		1.202	N10		31.58	.310		...	N10	
						31.57	0.0		1.302	N10	

A = Ag₂SO₄

* by algebraic extrapolation

SS = Solid Solution

N10 = Na₂SO₄·10H₂O

The System Silver Sulfate - Sodium Sulfate - Water (Cont.)

Results at 33°

Gms. per 100 Gms. H ₂ O		Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄	
0.25	0.861	SS
0.98	0.816	SS
2.01	0.832	SS
3.00	0.867	SS
5.34	0.972	SS
10.05	1.150	SS
20.09	1.448	SS
29.55	1.570	SS
39.44	1.462	SS
46.976	0.932	SS

Results at 35°

gms. per 100 gms. Sat. Sol.		Wt. % Ag ₂ SO ₄ in anhyd. SS*	Den- sity Sat. Sol.	Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄			
0.0	0.933	...	1.002	A
.57	.836	100.1	1.007	SS
1.04	.827	100.2	1.011	SS
1.58	.824	99.4	1.016	SS
2.04	.837	100.1	1.019	SS
3.62	.877	99.3	1.034	SS
5.24	.924	100.2	1.048	SS
7.54	1.01	97.8	1.073	SS
10.35	1.08	96.7	1.099	SS
12.42	1.122	95.0	1.115	SS
15.32	1.184	93.9	1.153	SS
17.23	1.203	91.5	1.165	SS
22.35	1.207	86.5	1.222	SS
25.53	1.092	77.0	1.257	SS
27.86	1.007	70.2	1.275	SS
29.22	0.931	61.8	1.290	SS
30.24	.828	49.4	1.305	SS
31.03	.699	...	1.308	SS
31.42	.653	38.1	1.311	SS
31.48	.597	28.0	1.312	SS
31.89	.530	25.8	1.315	SS
32.13	.481	12.3	1.316	SS
32.99	0.0	0.0	1.319	N

Results at 51°

Gms. per 100 Gms. H ₂ O		Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄	
0.25	1.032	SS
1.02	0.995	SS
1.90	1.017	SS
2.92	1.053	SS
5.40	1.173	SS
10.11	1.379	SS
20.25	1.705	SS
29.23	1.802	SS
39.30	1.540	SS
44.46	0.882	SS

Results at 75°

Gms. per 100 Gms. H ₂ O		Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄	
0.20	1.215	SS
0.98	1.210	SS
1.96	1.238	SS
2.98	1.296	SS
5.37	1.458	SS
9.81	1.697	SS
19.98	2.075	SS
29.66	2.138	SS
38.94	1.603	SS
41.36	1.156	SS

Results at 100°

Gms. per 100 Gms. H ₂ O		Solid Phase
Na ₂ SO ₄	Ag ₂ SO ₄	
0.50	1.341	
1.01	1.363	
1.94	1.418	SS
3.02	1.494	SS
5.33	1.651	SS
10.15	2.012	SS
25.45	2.351	SS
34.72	2.012	SS
38.63	1.687	SS
40.16	1.158	SS

*by algebraic extrapolation.

†metastable.

SS = Solid Solution

A = Ag₂SO₄N = Na₂SO₄

Ag ARGENTUM

THE SYSTEM SILVER SULFATE - RUBIDIUM SULFATE - WATER AT 25° (Von Dohlen and Simons, 1951)

gms. per 100 gms. Sat. Sol.		Den- sity Sat. Sol.	Solid Phase	gms. per 100 gms. Sat. Sol.		Den- sity Sat. Sol.	Solid Phase
Ag ₂ SO ₄	Rb ₂ SO ₄			Ag ₂ SO ₄	Rb ₂ SO ₄		
0.79	5.85	1.052	Ag ₂ SO ₄	1.33	30.85	1.336	Ag ₂ SO ₄
0.92	12.99	1.126	"	1.37	32.93	1.359	"
1.10	20.45	1.200	"	1.38	33.63	1.372	" + Rb ₂ SO ₄
1.18	24.41	1.252	"	0.62	33.72	1.355	Rb ₂ SO ₄
1.23	26.13	1.272	"	0.0	33.77	1.348	"
SO 1.30	28.95	1.316	"				

SOLUBILITY OF SILVER SULFATE IN SOLUTIONS OF ZINC SULFATE AT 25° (Akerlof and Thomas, 1934)

Solvent: moles ZnSO ₄ per 1000 gms. H ₂ O	moles Ag ₂ SO ₄ per 1000 gms. Sat. Sol.	Solvent: moles ZnSO ₄ per 1000 gms. H ₂ O	moles Ag ₂ SO ₄ per 1000 gms. Sat. Sol.
0.1225	0.02567	0.8285	0.03399
0.2528	0.02715	0.9601	0.03529
0.3855	0.02885	1.152	0.03707
0.5256	0.03058	1.322	0.03842
0.6784	0.03234	1.507	0.03971

SOLUBILITY OF SILVER SULFATE IN SOLUTIONS OF POTASSIUM AND MAGNESIUM NITRATES AT 25° (Harkins, 1911; Chloupek and Danes, 1932)

In KNO ₃ solutions			In Mg(NO ₃) ₂ solutions		
moles KNO ₃ per liter of solvent	moles AgNO ₃ per 1000 g sat. sol.	density sat. sol.	equiv. Mg(NO ₃) ₂ per liter	gms. Ag ₂ SO ₄ per liter sat. sol.	density Sat. Sol.
0.02491	0.02865	1.0072 (H.)	0.02476	9.267	1.0073
.0300	.02946	... (C.D.)	.04950	10.029	1.0094
.04977	.03028	1.0092 (H.)	.09946	11.334	1.0133
.0600	.03137	... (C.D.)			
.09987	.03336	1.0034 (H.)			
.1500	.03640	... (C.D.)			
.600	.05284	... (C.D.)			
1.500	.07645	... (C.D.)			

SOLUBILITY OF SILVER SULFATE IN PYRIDINE SOLUTIONS AT 25°
(Vosburgh and Cogswell, 1943)

gms. per 1000 gms. H ₂ O	Pyridine	1.167	1.641	2.853	4.344
	Ag ₂ SO ₄	9.992	10.380	11.749	13.343

SOLUBILITY OF SILVER SULFATE IN DIOXANE-WATER MIXTURES AT 25°
(Davis and Ricci with Sauter, 1939)

Wt. % Dioxane	Mol. % Dioxane	Density of solvent	Gms. Ag ₂ SO ₄ per 1000 cc. sat. sol.	Moles Ag ₂ SO ₄ per 1000 cc. sat. sol.	\$0
0	0.0	0.9970	8.369	0.02684	
10	2.223	1.0030	4.833	.01550	
20	4.667	1.0097	2.592	.008314	
30	8.063	1.0189	1.252	.004015	
40	12.004	1.0263	0.531	.001703	
50	16.987	1.0311	.1877	.000602	
60	23.485	1.0345	.0561	.000180	
70	32.32	1.0372	.0196	.00063	
80	45.01	1.0349	.0072	.000023	
90	64.81	1.0295	.00196	.0000063	
100	100.0	1.0277	.00000	.00000000	

SOLUBILITY IN SILVER SULFATE IN AQUEOUS 0.5 n SOLUTIONS OF
VARIOUS ORGANIC COMPOUNDS AT 25°
(Rothmund, 1910)

Solvent: Aq. 0.5 n Solution of:	Gms. Ag ₂ SO ₄ per liter sat. sol.	Solvent: Aq. 0.5 n Solution of:	Gms. Ag ₂ SO ₄ per liter sat. sol.
Methyl Alcohol	7.764	Dimethylpyrone	6.736
Ethyl Alcohol	7.109	Urethan	7.078
Propyl Alcohol	6.798	Formamide	3.42
Amyl Alc. (tert.)	6.36	Acetamide	7.794
Acetone	6.86	Acetonitrile	16.37
Ether	6.424	Glycoccol	13.50
Formaldehyde	7.078	Acetic Acid	7.857
Glycol	8.076	Phenol	11.81
Glycerol	8.202	Chloral	7.266
Mannitol	9.262	Methylal	.393
Grape Sugar	8.418	Methyl Acetate	.61
Urea	9.448		

Melting point data are given for the following:

Ag ₂ SO ₄ + Na ₂ SO ₄	(Naken, 1900)
Ag ₂ SO ₄ + K ₂ SO ₄	(Naken, 1907a)
Ag ₂ SO ₄ + H ₂ SO ₄	(Kendall and Davidson, 1921)
Ag ₂ SO ₄ + Li ₂ SO ₄	(Lesnykh and Bergman, 1953)

Ag ARGENTUM

50 SILVER THIOSULFATE $\text{Ag}_2\text{S}_2\text{O}_3$

EQUILIBRIUM IN THE SYSTEM SILVER THIOSULFATE, SODIUM
THIOSULFATE AND WATER AT 25°
(Bassett and Lemon, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Na}_2\text{S}_2\text{O}_3$	$\text{Ag}_2\text{S}_2\text{O}_3$	
0.29	0.55	$\text{NaAg}_2(\text{S}_2\text{O}_3)_2 \cdot \text{H}_2\text{O}$
0.43	0.75	"
0.51	0.88	" + $\text{NaAg}(\text{S}_2\text{O}_3) \cdot \text{H}_2\text{O}$
0.53	0.91	" "
0.61	1.05	" "
0.63	1.04	$\text{NaAg}(\text{S}_2\text{O}_3) \cdot \text{H}_2\text{O}$
1.82	2.46	"
5.28	5.46	"
12.54	10.98	"
20.04	17.42	"
27.24	21.64	"
27.56	21.91	" + $\text{Na}_5\text{Ag}_3(\text{S}_2\text{O}_3)_4 \cdot 2\text{H}_2\text{O}$
27.79	21.87	$\text{Na}_5\text{Ag}_3(\text{S}_2\text{O}_3)_4 \cdot 2\text{H}_2\text{O}$
32.40	19.36	"
33.90	18.02	"
35.98	17.76	" + $\text{Na}_2\text{Ag}(\text{S}_2\text{O}_3)_3 \cdot 2\text{H}_2\text{O}$
36.13	17.75	"
36.49	15.81	$\text{Na}_2\text{Ag}(\text{S}_2\text{O}_3)_3 \cdot 2\text{H}_2\text{O}$
38.28	12.52	"
41.48	8.90	"
42.27	8.13	"
43.31	7.30	" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
42.99	7.07	$\alpha\text{-Na}_2\text{S}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$
43.06	5.50	"
42.92	1.66	"
43.15	0.0	"

This system has also been studied by Brintzinger and Eckart, 1937, for the purpose of learning by dialysis experiments, the character of the ions in the solutions in contact with the several solid phases.

50M SILVER SULFAMATE AgSO_3NH_2

SOLUBILITY IN WATER
(Odehnal, 1955)

Gms. AgSO_3NH_2 per 100 gms. sat. sol.		Gms. AgSO_3NH_2 per 100 gms. sat. sol.		Gms. AgSO_3NH_2 per 100 gms. sat. sol.	
t°		t°		t°	
0	2.25	40	13.26	55	19.39
25	8.09	45	15.08	60	22.17
30	9.35	50	16.80	65	25.13
35	11.53				

SILVER SELENIDE Ag_2Se

Se

SOLUBILITY OF SILVER SELENIDE IN AQUEOUS AMMONIA SOLUTIONS
(Young and Colledge, 1947)

		Gms. per 100 ml. Solvent at		
		23°	34°	64°
Conc. NH_3	(26.3% NH_3 by wt., D. = 0.906)	0.0260	0.0250	...
1:1 NH_3		0.0262	...	0.0240

(34° and 64° are the respective boiling points of the conc. and 1:1 NH_3 used.)

Fusion point data for mixtures of Ag_2Se and Bi_2Se_3 are given by Pelabon, 1908.

SILVER SELENATE Ag_2SeO_4

SeO

SOLUBILITY IN WATER

(Lohner and Kao, 1925; Meyer and Hinke, 1932; Gelbach and King, 1942)

The results of various authors do not agree. Gelbach and King prepared their analytically pure salt from $\text{MgSeO}_4 \cdot 6\text{H}_2\text{O}$ and AgNO_3 and approached equilibrium from both under- and super saturation. Their calculated solubility product constant at 25° is 5.65×10^{-8} .

t°	gms. Ag_2SeO_4 per 1000 gms. H_2O	density sat. sol.	t°	gms. Ag_2SeO_4 per 1000 gms. H_2O
20	1.182	..... (L.&K.)	40	0.029 (M.&H.)
20.4	0.016	..... (M.&H.)	50	0.033 (")
25	0.870	0.99793 (G.&K.)	100	0.053 (")
30	0.026	..... (M.&H.)		

SOLUBILITY OF SILVER SELENATE IN SOLUTIONS OF SELENIC ACID AT 25°
(Gelbach and King, 1942)

moles H_2SeO_4 per liter	gms. Ag_2SeO_4 per liter	moles H_2SeO_4 per liter	gms. Ag_2SeO_4 per liter
0.0	0.868	0.0222	0.527
.00564	.635	.0566	.484
.01113	.581	.1218	.481

Ag ARGENTUM

SeO SILVER o and p Xylole SELENATES $(CH_3)_2(1,2)C_6H_3(4)SeO_3Ag$ and $(CH_3)_2(1,4)C_6H_3(4)SeO_3Ag.H_2O$.

100 gms. H_2O dissolve 1.29 gms. of the ortho compound at 23° .
 " " " " 3.02 " " " anhydrous para compound at 18° .
 (Auschutz, Kallen and Riepenkroger, 1919.)

SeCN SILVER SELENO CYANIDE $AgSeCN$

One liter sat. solution in H_2O contains 4.0×10^{-6} gm. $AgSeCN$ at $18-20^\circ$ as determined by E.M.F. measurements. (Birckenbach and Huttner, 1930.)

Te SILVE TELLURIDE Ag_2Te

SOLUBILITY OF SILVER TELLURIDE IN AQUEOUS AMMONIA SOLUTIONS (Young and Colledge, 1947)

		Gms. per 100 ml. Solvent		
		23°	34°	64°
Conc. NH_3	(26.3% NH_3 by wt., D. = 0.906	0.0008	0.00025	....
1:1 NH_3		0.0007	....	0.0020

34° and 64° are the respective boiling points of the conc. and 1:1 NH_3 used.

VO SILVER VANADATES $AgVO_3$, $Ag_4V_2O_7$, $Ag_6V_4O_{13}$

Britton and Robinson, 1930 titrated sodium vanadate solutions with $AgNO_3$ and found three solid phases: $AgVO_3$, $K_{sp} = 5 \times 10^{-7}$; Ag_2HVO_4 , $K_{sp} = 2.9 \times 10^{-14}$; $Ag_3(HVO_4)(OH)$, $K_{sp} \sim 10^{-24}$. They show that when excess $AgNO_3$ is present a continuously varying ratio of Ag:V may occur in the precipitate.

Carnelly, 1873 reported that one liter of aqueous solution contains 0.047 gm. at 14° , and 0.073 gm. of $Ag_6V_4O_{13}$ at 100° . Souchay, 1951 determined the silver ion concentration in solutions containing various amounts of $NaVO_3$ + $NaNO_3$ and $Na_4V_4O_7$ + Na_2SO_4 and agrees with Britton & Robinson on the nature of the solid phases.

SILVER TUNGSTATE Ag_2WO_4

WO

SOLUBILITY IN WATER

t*	gms. Ag_2WO_4 per liter	
15°	0.5	(Hodgman, 1944)
25°	0.235	(Britton and German, 1934)
Not given	0.0266	(Bucholz, 1940)

(Ksp = 5.2×10^{-10})

ALUMINUM Al

Al

SOLUBILITY OF ALUMINUM IN MERCURY

(Klemm and Weiss, 1940a)

Excess aluminum was sealed with mercury in an evacuated quartz tube. Mixtures were heated to each temperature for 24 hours, cooled, and the solution analyzed for both aluminum and mercury. Temperatures were $\pm 2^\circ$:

Temperature	Wt. % Al	Atomic % Al
422°	1.01	7.5
435°	1.14	7.9
470°	1.83	12.2
502°	2.20	16.5
537°	5.99	32.2
560°	9.33	43.4
581°	20.61	65.4
595°	39.15	82.7

Fogh (1921) gives the solubility of aluminum in boiling mercury as 0.38%. Smits and DeGrunter (1921) give the solubility at room temperature as 0.002%.

The effect of time of immersion, temperature, and concentration of sodium hydroxide on the rate of dissolution of aluminum was studied by Streicher (1948).

SOLUBILITY OF METALLIC ALUMINUM IN MILK

(Quam, 1929)

Polished plates of aluminum immersed in milk kept in motion for periods of one-half hour at different temperatures showed no loss in weight up to 70° C. and 0.122 and 0.174 milligrams per sq. decimeter of surface at 80° and 95° respectively.

A hypothetical diagram of the system Al - Al_2S_3 showing limited solid solution is given by Kohlmeyer and Retzlaff, 1950.

The system $\text{Al} + 3\text{NaF} \rightleftharpoons \text{AlF}_3 + 3\text{Na}$ was studied at 1090° by Jander and Herrman (1938).

AI ALUMINUM

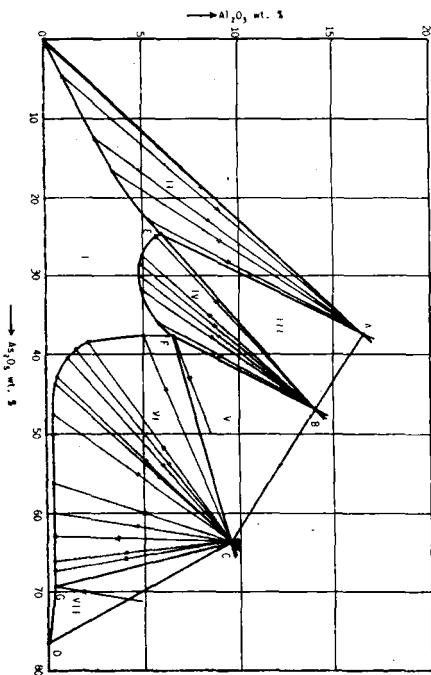
AsO ALUMINUM ARSENATES $x\text{Al}_2\text{O}_3 \cdot y\text{As}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

THE SYSTEM $\text{Al}_2\text{O}_3 - \text{As}_2\text{O}_5 - \text{H}_2\text{O}$ at 30°
(Takahashi and Sasaki, 1950)

No numerical data are given:

The authors found four saturating phases:

- A : $\text{Al}_2\text{O}_3 \cdot \text{As}_2\text{O}_5 \cdot 16\text{H}_2\text{O} = \text{AlAsO}_4 \cdot 8\text{H}_2\text{O}$
 B : $2\text{Al}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 32\text{H}_2\text{O} = \text{Al}_2(\text{HAsO}_4)_3 \cdot 14 \cdot 5\text{H}_2\text{O}$
 C : $\text{Al}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 16\text{H}_2\text{O} = \text{Al}(\text{H}_2\text{AsO}_4)_3 \cdot 5\text{H}_2\text{O}$
 D : $\text{As}_2\text{O}_5 \cdot 4\text{H}_2\text{O} = \text{H}_3\text{AsO}_4 \cdot 2 \cdot 5\text{H}_2\text{O}$



Results at 60°

Guerin and Martin, 1950 found the phases:

$\text{Al}_2\text{O}_3 \cdot \text{As}_2\text{O}_5 \cdot 2\text{H}_2\text{O}$ in contact with solutions containing 0.1 - 43.2 % As_2O_5
 $\text{Al}_2\text{O}_3 \cdot 2\text{As}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ in contact with solutions containing 43.2 - 71.5 % As_2O_5 .

ALUMINUM BROMIDE AlBr_3 ALUMINUM Al
Br

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS

[Data are in gms. AlBr_3 per 100 gms. sat. sol. unless otherwise specified]

t°	gms. AlBr_3 per 100 gms. sat. sol.	Solid Phase	
<u>In Aniline (6)</u>			
<u>In Benzene (1)(2)(3)(4)(6)</u>			
5.7 m. pt.	0	C_6H_6	
4.5	10	"	
3.0	20	"	
1.92 Eutec.	27.5	$\text{C}_6\text{H}_6 + \text{AlBr}_3 \cdot \text{C}_6\text{H}_6$	Br
10	35.3	$\text{AlBr}_3 \cdot \text{C}_6\text{H}_6$	
17.4	43.7	"	
20	46.5	"	
28.2	55.5	"	
34.3	63.6	"	
36.6	68.6	"	
37 incong. m. pt.	70.5	$\text{AlBr}_3 \cdot \text{C}_6\text{H}_6 + \text{AlBr}_3$	
40.1	72.8	AlBr_3	
51.5	80.1	"	
60.8	85.3	"	
72.0	89.9	"	
91.6	96.	"	
98.1	100.0	"	
<u>In Benzonitrile (5)(6)</u>			
-8	22.97	$\text{AlBr}_3 : 6\text{C}_6\text{H}_5\text{CN}$	
-5	23.50	"	
-2	24.21	" $\text{AlBr}_3 : 4.5\text{C}_6\text{H}_5\text{CN}$	
0	23.95	$\text{AlBr}_3 : 4.5\text{C}_6\text{H}_5\text{CN}$	
5	22.85	"	
10	22.35	"	
15	21.09	" + $\text{AlBr}_3 : 4\text{C}_6\text{H}_5\text{CN}$	
18	23.25	$\text{AlBr}_3 : 4\text{C}_6\text{H}_5\text{CN}$	
22	25.12	"	
25	27.47	"	
30	29.05	"	
40	29.62	$\text{AlBr}_3 : 2\text{C}_6\text{H}_5\text{CN}$	
50	30.17	"	
60	30.25	"	
70	30.53	$\text{AlBr}_3 : \text{C}_6\text{H}_5\text{CN}$	
80	31.35	"	
90	31.85	"	
100	32.56	"	

- (1) Menshutkin, 1909-10
- (2) Andreevskii, 1955
- (3) Eley and King, 1951
- (4) Plotnikov and Gratsianski, 1939
- (5) Muller, 1932a
- (6) Kahlukow and Sachsnow, 1909

A1 ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

	t°	gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
<u>In Benzophenone (1)</u>			
	48 m. pt.	0	(C ₆ H ₅) ₂ CO
	45	12	"
	42	19	"
	38 Eutec.	24.7	" + AlBr ₃ ·(C ₆ H ₅) ₂ CO
	60	30.9	AlBr ₃ ·(C ₆ H ₅) ₂ CO
	80	36.4	"
Br	100	42.2	"
	120	49	"
	130	53	"
	142 m. pt.	59.5	"
	130	64	"
	100	69	"
	70	72.2	"
	50	74	"
	38 Eutec.	75	" + AlBr ₃
	50	78	AlBr ₃
	80	88	"
	90	93.5	"
	96	100	"
<u>In Benzoyl Chloride (1)</u>			
	-0.5 m. pt.	0	C ₆ H ₅ COCl
	-2.5	11.7	"
	-5 Eutec.	22.2	C ₆ H ₅ COCl + AlBr ₃ ·C ₆ H ₅ COCl
	20	33.7	AlBr ₃ ·C ₆ H ₅ COCl
	40	42.6	"
	60	51.6	"
	80	60.5	"
	90 m. pt.	65.5	"
	80	68.0	"
	60	71.8	"
	30	75.8	"
	7 Eutec.	78.8	AlBr ₃ ·C ₆ H ₅ COCl + AlBr ₃
	20	80.6	AlBr ₃
	50	85.6	"
	80	93.2	"
	96	100	"

(1) Menshutkin, 1909-10

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
<u>In p-Bromoaniline (6)</u>		
<u>In Bromobenzene (6)(7)</u>		
	(Mole % AlBr ₃)	
-30.6	0	C ₆ H ₅ Br
-40	5	"
-50	10	"
-56	13	C ₆ H ₅ Br + AlBr ₃
-50	14.5	AlBr ₃
-40	17	"
-30	19.5	"
-20	22.5	"
-10	26	"
0	30.5	"
10	35	"
20	40	"
30	46	"
40	53	"
50	60	"
60	67.5	"
70	74	"
80	82	"
90	91.5	"
<u>In Bromoform (7)</u>		
	(Mole % AlBr ₃)	
+7	0	CHBr ₃
+5	11	"
-1	17	CHBr ₃ + AlBr ₃
+10	26	AlBr ₃
20	34.5	"
30	43	"
40	43	"
40	52	"
50	60	"
60	68	"
70	77	"
80	85	"
90	93	"

(6) Kahlukow and Sechanow, 1909

(7) Burbage and Garrett, 1952

A1 ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

		gms. AlBr_3 per 100 gms. sat. sol.	Solid Phase
<u>In o-Bromonitrobenzene (1)</u>			
Br	38 m. pt.	0	$\text{o-C}_6\text{H}_4\text{BrNO}_2$
	30	19.7	"
	21 Eutec.	30	" + $\text{AlBr}_3 \cdot \text{o-C}_6\text{H}_4\text{BrNO}_2$
	40	37.6	$\text{AlBr}_3 \cdot \text{o-C}_6\text{H}_4\text{BrNO}_2$
	60	45.3	"
	80	53	"
	88.5 m. pt.	56.9	"
	80	59.7	"
	60	64.1	"
	40	68.6	"
	24 Eutec.	72	" + AlBr_3
	40	75.5	AlBr_3
	60	79.8	"
	80	86.3	"
	93	94.5	"
	96	100	"
<u>In m-Bromonitrobenzene (1)</u>			
	54 m. pt.	0	$\text{m-C}_6\text{H}_4\text{BrNO}_2$
	50	11.6	"
	45.5 Eutec.	19.5	" + $\text{AlBr}_3 \cdot \text{m-C}_6\text{H}_4\text{BrNO}_2$
	60	25.5	$\text{AlBr}_3 \cdot \text{m-C}_6\text{H}_4\text{BrNO}_2$
	80	34.5	"
	110	49.5	"
	122 m. pt.	56.9	"
	110	61.6	"
	80	69.2	"
	60	74.1	"
	42 Eutec.	78.7	" + AlBr_3
	60	80.3	AlBr_3
	80	84.9	"
	93	93.6	"
	96	100	"

(1) Menshutkin, 1909-10

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
<u>In p-Bromonitrobenzene (1)</u>		
124.5 m. pt.	0	p-C ₆ H ₄ BrNO ₂
119	10	"
110	25.2	"
98 Eutec.	35.3	" + AlBr ₃ ·pC ₆ H ₄ BrNO ₂
110	39.7	AlBr ₃ ·pC ₆ H ₄ BrNO ₂
130	48.7	"
144 m. pt.	56.9	"
120	65.5	"
90	70.5	"
60	74.1	"
45 Eutec.	76	" + AlBr ₃
60	79.6	AlBr ₃
80	86.6	"
93	95.4	"
96	100	"

In n-Butane (8)

Temperatures at which known amounts of AlBr₃ completely dissolved were determined. Connections for n-Butane in the vapor at each temperature were applied.

28.3	32.62	AlBr ₃
32.2	37.30	"
38.8	46.77	"
43.2	52.63	"
48.6	59.70	"
53.4	67.27	"
57.6	75.89	"
67.0	84.18	"
74.1	89.99	"
80.9	94.20	"
89.9	97.81	"
97.5	100.0	"

(1) Menshutkin, 1909-10

(8) Heldman and Thurmond, 1944

Al ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

	gms. AlBr_3 per 100 gms. sat. sol.		Solid Phase
<u>In Carbon Disulfide (9)</u>			
	0.1	41.7	AlBr_3
	8.4	49.1	"
	15.0	55.1	"
	20.0	58.8	"
	25.0	62.7	"
	30.0	66.7	"
Br	50.1	80.9	"
	60.0	86.4	"
	70.0	90.5	"
	71.0	91.1	"
	76.0	93.5	"
	81.0	94.5	"
	85.0	96.2	"
	91.7 (m. pt.)	100.0	"
<u>In o-Chloronitrobenzene (1)</u>			
	32.5 m. pt.	0	$\text{oC}_6\text{H}_4\text{ClNO}_2$
	25	21.8	"
	13.8 Eutec.	37.5	" + $\text{AlBr}_3 \cdot \text{oC}_6\text{H}_4\text{ClNO}_2$
	30	43.1	$\text{AlBr}_3 \cdot \text{oC}_6\text{H}_4\text{ClNO}_2$
	50	50.3	"
	70	57.6	"
	83.5 m. pt.	62.9	"
	70	67	"
	40	73.7	"
	21 Eutec.	77.5	" + AlBr_3
	40	80.6	AlBr_3
	60	84	"
	80	88.6	"
	90	93.4	"
	96	100	"
<u>In m-Chloronitrobenzene (1)</u>			
	44.5 m. pt.	0	$\text{mC}_6\text{H}_4\text{ClNO}_2$
	40	18.9	"
	35.5 Eutec.	27.8	" + $\text{AlBr}_3 \cdot \text{mC}_6\text{H}_4\text{ClNO}_2$
	50	34.8	$\text{AlBr}_3 \cdot \text{mC}_6\text{H}_4\text{ClNO}_2$
	70	44.5	"
	90	54.5	"
	103.5 m. pt.	62.9	"
	90	68.6	"
	70	73.4	"
	50	77.3	"
	40 Eutec.	79.1	" + AlBr_3
	60	82.2	AlBr_3
	80	87.1	"
	90	92.2	"
	95	95.1	"
	96	100	"

(1) Menshutkin, 1909-1910

(9) Kaveler and Monroe, 1928

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

t°		gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
<u>In p-Chloronitrobenzene (1)</u>			
83	m. pt.	0	p-C ₆ H ₄ ClNO ₂
80		9	"
70		24.8	"
60	Eutec.	36.6	" + AlBr ₃ ·pC ₆ H ₄ ClNO ₂
80		45.6	AlBr ₃ ·pC ₆ H ₄ ClNO ₂
100		54.9	"
115	m. pt.	62.9	"
100		66.8	"
60		72.4	"
20	Eutec.	78.0	" + AlBr ₃
60		85.3	AlBr ₃
80		89.3	"
93		95.4	"
96		100	"
<u>In Cyclohexane (10)</u>			
6.2		25.1	AlBr ₃
8.8		27.6	"
17.2		35.2	"
26.4		45.1	"
28.5		47.4	"
36.0		55.0	"
37.6		56.4	"
38.7		57.9	"
39.8		59.4	"
44.5		64.2	"
57.0		76.0	"
60.3		79.5	"
61.7		80.4	"
97.5		100.0	"

(1) Menshutkin, 1909-10

(10) Leighton and Wilkes, 1948

Al ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

t°		gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
<u>In p-Dibromobenzene (6)</u>			
<u>In Dimethylaniline (6)</u>			
<u>In Dimethylpyrone (11)</u>			
<u>In Ethyl Bromide (7)</u>			
		(Mole % AlBr ₃)	
Br	-118 m. pt.	0	C ₂ H ₅ Br
	-132	10	C ₂ H ₅ Br + AlBr ₃ ·C ₂ H ₅ Br
	-110	21	AlBr ₃ ·C ₂ H ₅ Br
	-90	33	"
	-70	44	"
	-62 m. pt.	50	"
	-68	52	AlBr ₃ ·C ₂ H ₅ Br + AlBr ₃
	-50	53	AlBr ₃
	-20	55	"
	0	57	"
	20	60	"
	40	63	"
	60	68	"
	80	78	"
	95	94	"
<u>In Ethylene Bromide (1)</u>			
	10 m. pt.	0	C ₂ H ₄ Br ₂
	6	11.5	"
	2	21.3	"
	-2 Eutec.	29.7	C ₂ H ₄ Br ₂ + AlBr ₃
	10	36.1	AlBr ₃
	20	42.1	"
	30	48.7	"
	40	56.0	"
	50	63.7	"
	60	71.5	"
	70	79.1	"
	80	86.8	"
	90	94.5	"
	96	100	"

- (1) Menshutkin, 1909-10
 (6) Kahlukow and Sachanow, 1909
 (7) Burbage and Garrett, 1952
 (11) Plotnikow, 1911

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS—Contd.

t°	gme. AlBr ₃ per 100 gms. sat. sol.	Solid Phase	
<u>In Ethylene Bromide</u>			
+ SbBr ₃			
+ (C ₂ H ₅) ₂ O (12)			
(data up to about +5°)			
<u>In m-Hexane (14)</u>			
30.6	31.0	AlBr ₃	Br
33.1	34.5	"	
40.5	42.0	"	
44.1	46.5	"	
48.5	51.5	"	
50.0	54.0	"	
53.9	58.8	"	
55.0	62.1	"	
60.5	70.7	"	
69.8	81.7	"	
72.6	84.8	"	
82.4	92.9	"	
86.6	95.0	"	
97.5	100.0	"	
<u>In Methylaniline (6)</u>			
<u>In Methyl Benzoate (6)</u>			
<u>In Methyl Bromide (13)</u>			
	(Mole % AlBr ₃)		
-80	17.7	AlBr ₃	
-64.4	24.0	"	
-45.8	30.3	"	
-31.3	34.3	"	
0	48.4	"	

- (6) Kahlukow and Sachanow, 1909
 (12) Gorenbein, 1954
 (13) Brown and Wallace, 1953
 (14) Boedeker and Oblad, 1947

Al ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

		gms. AlBr_3 per 100 gms. sat. sol.	Solid Phase
<u>In Methylene Bromide (6)</u>			
<u>In Naphthalene (6)</u>			
<u>In Nitrobenzene (1)(6)</u>			
	5.5 m. pt.	0	$\text{C}_6\text{H}_5\text{NO}_2$
	0	18.0	"
	-5	28.8	"
	-15 Eutec.	42.0	" + $\text{AlBr}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$
Br	0	44.3	$\text{AlBr}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$
	30	49.4	"
	60	56.7	"
	80	63.6	"
	87 m. pt.	68.4	"
	80	71.3	"
	60	73.9	"
	40	76.4	"
	20 Eutec.	78.9	" + AlBr_3
	40	82.4	AlBr_3
	60	85.8	"
	80	89.8	"
	93	96.6	"
	96	100	"
<u>In o-Nitrotoluene (1)</u>			
	-8.5 m. pt.	0	$\text{oC}_6\text{H}_4\text{CH}_3\text{NO}_2$
	-11 Eutec.	8.7	" + $\text{AlBr}_3 \cdot 2\text{oC}_6\text{H}_4\text{CH}_3\text{NO}_2$
	10	12.8	$\text{AlBr}_3 \cdot 2\text{oC}_6\text{H}_4\text{CH}_3\text{NO}_2$
	30	24.8	"
	40	38.0	"
	42.5 Eutec.	47.7	" + $\text{AlBr}_3 \cdot 2\text{oC}_6\text{H}_4\text{CH}_3\text{NO}_2$
	60	54.3	$\text{AlBr}_3 \cdot \text{oC}_6\text{H}_4\text{CH}_3\text{NO}_2$
	75	59.5	"
	90 m. pt.	66.0	"
	70	72.0	"
	40	76.1	"
	19 Eutec.	79.1	" + AlBr_3
	40	82.5	AlBr_3
	70	87.5	"
	90	93.8	"
	96	100	"

- (1) Menahutkin, 1909-10
 (6) Kahlukow and Sachanow, 1909

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

		gms. AlBr_3 per 100 gms. sat. sol.	Solid Phase
<u>In m-Nitrotoluene (1)</u>			
16	m. pt.	0	$\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
12		14.5	"
8		21.8	"
1	Eutec.	32.0	" + $\text{AlBr}_3 \cdot \text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
20		38.5	$\text{AlBr}_3 \cdot \text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
40		46.6	"
80		59.7	"
90		63.3	"
96	m. pt.	66.0	"
90		68.8	"
60		73.8	"
27	Eutec.	78.9	" + AlBr_3
40		82.0	AlBr_3
70		89.0	"
90		95.3	"
96		100	"
<u>In p-Nitrotoluene (1)</u>			
53.5	m. pt.	0	$\text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
50		10.0	"
40		31.3	"
29	Eutec.	46.1	" + $\text{AlBr}_3 \cdot \text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
50		52.9	$\text{AlBr}_3 \cdot \text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
80		63.0	"
88	m. pt.	66.0	"
80		68.5	"
50		74.3	"
27	Eutec.	78.9	" + AlBr_3
50		83.3	AlBr_3
70		87.7	"
85		92.2	"
93		96.7	"
96		100	"

(1) Menshutkin, 1909-10

Al ALUMINUM

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

	gms. AlBr_3 per 100 gms. sat. sol.	Solid Phase
<u>In Pyridine</u> (5)(6)(15)		
-11	1.86	$\text{AlBr}_3:7.5\text{C}_5\text{H}_5\text{N}$
-7	3.00	"
0	5.36	"
2	5.72	" + $\text{AlBr}_3:5.5\text{C}_5\text{H}_5\text{N}$
3	4.88	$\text{AlBr}_3:5.5\text{C}_5\text{H}_5\text{N}$
4	2.05	" + $\text{AlBr}_3:6\text{C}_5\text{H}_5\text{N}$
5	3.52	$\text{AlBr}_3:6\text{C}_5\text{H}_5\text{N}$
6	4.32	"
7	6.09	" + $\text{AlBr}_3:3\text{C}_5\text{H}_5\text{N}$
10	5.65	$\text{AlBr}_3:3\text{C}_5\text{H}_5\text{N}$
13.5	5.1	"
20	3.86	"
30	1.93	"
35	1.00	"
40	0.38	" + $\text{AlBr}_3:\text{?C}_5\text{H}_5\text{N}$
60	0.41	$\text{AlBr}_3:\text{?C}_5\text{H}_5\text{N}$
80	0.55	"
100	1.03	"

The fusion point data of Plotnikow and Iwanow, 1951 (15) are not in good agreement with the above. The diagram of the results is made up of branches corresponding to the compounds AlBr₃·C₅H₅N (m. pt. 45°), Al₂Br₆·C₅H₅N (m. pt. 83°), 2Al₂Br₆·3C₅H₅N and Al₂Br₆·2C₅H₅N (m. pt. 98°).

In Toluene (1)(6)

-15	16.1	AlBr ₃
0	23.7	"
10	32.1	"
20	42.5	"
30	56	"
40	68.8	"
50	76.5	"
70	87.2	"
90	95.7	"
96	100	"

- (1) Menshutkin, 1909-10
- (5) Muller, 1932a
- (6) Kahlukow and Sachanow, 1909
- (15) Plotnikow and Iwanow, 1931

SOLUBILITY OF ALUMINUM BROMIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlBr ₃ per 100 gms. sat. sol.	Solid Phase
In p-Xylene (Menshutkin, 1909-10; Kahlukow and Sachanow, 1909)		
14 m. pt.	0	pC ₆ H ₄ (CH ₂) ₂
12.5	11.4	"
10.2 Eutec.	25	AlBr ₃ + pC ₆ H ₄ (CH ₂) ₂
20	35.7	AlBr ₃
30	47.2	"
40	61.2	"
50	72.2	"
60	79.6	"
80	90.9	"
90	95.4	"
96	100	"

8r

Melting point data for the systems

AlBr₃ - CsCl - C₆H₅NO₂
 AlBr₃ - LiCl - C₆H₅NO₂
 AlBr₃ - RbCl - C₆H₅NO₂
 AlBr₃ - RbI - C₆H₅NO₂

are given by Mezheni, 1940.

SOLUBILITY OF ALUMINUM BROMIDE IN BORON TRIBROMIDE
(Adamsky and Wheeler, Jr., 1954)

Read from the authors' curves.

t°	Mole % AlBr ₃ in Sat. Sol.	Solid Phase	t°	Mole % AlBr ₃ in Sat. Sol.	Solid Phase
-46.1	10.5	AlBr ₃ + BBr ₃	+20	31	AlBr ₃
-20	13.5	AlBr ₃	40	44	"
0	20	"	60	59	"
			80	78	"

SOLUBILITY OF ALUMINUM BROMIDE IN BROMINE
(Pusin and Makuc, 1938; Burbage and Garrett, 1952)

The results are not in good agreement. All data were read from the authors' curves. Data in parentheses are those of Pusin and Makuc.

t°	Mole % AlBr ₃ in Sat. Sol.	Solid Phase	t°	Mole % AlBr ₃ in Sat. Sol.	Solid Phase
-10	13	Br ₂	40	55(36)	AlBr ₃
-18.5(-13.5)	20(12)	Br ₂ + AlBr ₃	50	61	"
-10	24	AlBr ₃	60	69(50)	"
0	29(17)	"	70	77	"
+10	35	"	80	85(71)	"
20	41(25)	"	90	93	"
30	48	"			

Al ALUMINUM

The solid solutions formed by $\text{AlBr}_3 + \text{AlCl}_3$ at 24° , 40° and 75° have been studied in the systems $\text{AlBr}_3 + \text{AlCl}_3$ and $\text{AlBr}_3 + \text{AlCl}_3 + \text{HBr} + \text{HCl}$ by Corbett and Gregory, 1953.

Melting point data have been determined for:

$\text{AlBr}_3 + \text{AgBr}$ (3)	$\text{AlBr}_3 + \text{IBr}$ (9)	$\text{AlBr}_3 + \text{NaCl}$ (8)
" + AlCl_3 (2)(5)	" + KBr (3)(6)	" + NaI (7)
" + AsBr_3 (2)(3)	" + KCl (8)	" + PBr_3 (1)(3)(5)
" + BaBr_2 (3)	" + LiBr (3)	" + PbBr_2 (3)
" + BiBr_3 (2)(3)	" + MgBr_2 (3)	" + SbBr_3 (2)(3)
" + CBr_4 (2)(3)	" + MnBr_2 (3)(5)	" + SnBr_2 (3)
" + CaBr_2 (3)	" + HH_4Br (3)	" + SnBr_4 (3)(5)
" + HgBr (3)	" + NH_3 (4)	" + TiBr_4 (10)
" + HgBr_2 (2)(3)	" + NaBr (3)(6)	" + TlBr (3)
		" + ZnBr_2 (3)

(1) = Isbekow, 1913; (2) = Isbekow, 1925; (3) = Kendall, Crittenden and Miller, 1923; (4) = Klemm and Redeker, 1931; (5) = Pusin and Makuc, 1938; (6) = Gorenbein and Kriss (1949); (7) = Daniel and Gregory, 1950; (8) = Starckadomskaja, 1939; (9) = Fialkov and Shor, 1953; (10) = Ringorn, 1950.

Br ALUMINUM BROMIDE dimethyl etherate $\text{AlBr}_3 \cdot (\text{CH}_3)_2\text{O}$

The solubility of $\text{AlBr}_3 \cdot (\text{CH}_3)_2\text{O}$ in methyl bromide solutions containing propane, *n*-butane, iso-butane, and *n*-pentane was determined by Foster and Kraus, 1953.

C ALUMINUM TRIFLUOROACETATE $(\text{CF}_3\text{COO})_3\text{Al}$

SOLUBILITY IN TRIFLUOROACETIC ACID AT 29.8°
(Harra and Cady, 1954)

gms. per 100 gms. CF_3COOH		Solid Phase
$(\text{CF}_3\text{COO})_3\text{Al}$	CF_3COONa	
0.01	0.0	$(\text{CF}_3\text{COO})_3\text{Al}$
Trace	13.0	$(\text{CF}_3\text{COO})_3\text{Al} + \text{CF}_3\text{COONa} \cdot 2\text{CF}_3\text{COOH}$

ALUMINUM TETRACHLOROPHTHALATE $\text{Al}_2(\text{C}_6\text{Cl}_4\text{COO})_3$

100 gms. of a saturated solution of the salt in water contains 0.35 gms. at 25° . (Lawlor, 1947.)

ALUMINUM CUPFERRATE (NITROSOPHENYL HYDROXYLAMINE) $\text{Al}(\text{C}_6\text{H}_5\text{H}_2\text{O}_2)_3$

CH

The solubility in water of the precipitated aluminum salt of nitroso phenylhydroxylamine, obtained by adding a solution of "cupferron" ($\text{C}_6\text{H}_5\cdot\text{N}(\text{NO})\text{O}\cdot\text{NH}_2$) to a solution of a soluble aluminum salt, was determined at 18° by a colorimetric method. The result corresponded to a solubility of 3.4×10^{-5} gm. atom Al per liter, equivalent to 0.0009 gm. $\text{Al}[\text{C}_6\text{H}_5\cdot\text{N}(\text{NO})\text{O}]_3$. (Martin and Pinkus, 1927.)

Pyatnitski (1946) found the solubility product to be 2.3×10^{-19} .

ALUMINUM OXINE (8-HYDROXYQUINOLATE) $\text{Al}(\text{C}_9\text{H}_6\text{NO})_3$

The solubility product in aqueous solution at room temperature is given as 5×10^{-33} by LaCroix, 1947 and 1.03×10^{-29} by Tinovskaya, 1950.

Moeller, 1943 and Gentry and Sherrington, 1950 studied the extraction of aluminum oxine from aqueous solutions with chloroform and found "complete" extraction at pH (4.3-4.6) and (4.8-6.7 and 8.2-11.5) respectively.

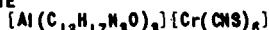
SOLUBILITY IN CHLOROFORM AT 18°

20.7 gms. per liter sat. sol.	(LaCroix, 1947)
17.4 " " " " "	(Dryssen and Dahlberg, 1953)

ALUMINUM 10 - CAMPHOR SULFONATE ACID $\text{Al}(\text{C}_{10}\text{H}_{15}\text{OSO}_3)_2$

CH

A saturated solution in water contains 86% by wt. of the trihydrate or 80% of the anhydrous salt. (Room temperature) (Pirrone, 1942.)

ALUMINUM PYRAMIDONE - CHROMIUM HEXA-THIOCYANATE
(AMINO-PYRINE)

0.07 gms. dissolve in 100 ml H_2O at 15°. (Gulyaeva, 1950.)

ALUMINUM HELIANTHATE $(\text{C}_{14}\text{H}_{14}\text{N}_3\text{SO}_3)_3\text{Al}\cdot 6\text{H}_2\text{O}$

100 cc. H_2O dissolve 0.0092 gms. $(\text{C}_{14}\text{H}_{14}\text{N}_3\text{SO}_3)_3\text{Al}\cdot 6\text{H}_2\text{O}$ at 20°-25°. (Stark and Dehn, 1918.)

ALUMINUM OLEATE $\text{Al}(\text{C}_{18}\text{H}_{33}\text{O}_2)_3$

100 gms. methyl alcohol dissolve 2.49 gms. $\text{Al}(\text{C}_{18}\text{H}_{33}\text{O}_2)_3$ at 15° and 4.47 gms. at 66°. (the b. pt.)

100 gms. acetone dissolve 0.39 gm. $\text{Al}(\text{C}_{18}\text{H}_{33}\text{O}_2)_3$ at 15°.

100 gms. benzene dissolve 0.58 gm. $\text{Al}(\text{C}_{18}\text{H}_{33}\text{O}_2)_3$ at 15°. (Henstock, 1934.)

Al ALUMINUM

CH ALUMINUM STEARATE $\text{Al}(\text{C}_{18}\text{H}_{35}\text{O}_2)_3$

100 gms. methyl alcohol dissolve 0.2 gm. $\text{Al}(\text{C}_{18}\text{H}_{35}\text{O}_2)_3$ at 66° (the b. pt.).

100 gms. acetone dissolve 0.88 gm. $\text{Al}(\text{C}_{18}\text{H}_{35}\text{O}_2)_3$ at 15°.

100 gms. benzene dissolve 0.18 gm. $\text{Al}(\text{C}_{18}\text{H}_{35}\text{O}_2)_3$ at 15°. (Henstock, 1934.)

SCN ALUMINUM THIOCYANATE $\text{Al}(\text{SCN})_3$

The extraction of aluminum thiocyanate from NH_4SCN solutions by ether has been studied by Fischer and Bock, 1941, Miller, 1947 and Stein, 1883.

Cl ALUMINUM CHLORIDE AlCl_3

SOLUBILITY IN WATER

(Tanaka, 1930; Malquori, 1927, 1928; Palitzsch, 1929; Seidel and Fischer, 1941; Ehret & Frere, 1945)

Solid phase $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ throughout

t°	Gms. AlCl_3 per 100 gms. sat. sol.	t°	Gms. AlCl_3 per 100 gms. sat. sol.	t°	Gms. AlCl_3 per 100 gms. sat. sol.
-55	25.3 (M)*	5	30.82 (T)	40	31.63 (M)
-40	26.8 (M)	10	31.66 (T)	45	32.17 (T)
-20	29.1 (M)	25	31.10 (P)	60	31.73 (M)
0	31.03 (M)		31.1 (E&F)	65	32.32 (T)
	30.48 (T)		34.08? (M)	98	33.23 (T)
	31.0 (S&F)	30	31.96 (T)		

*eutectic : solid phases Ice + $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$.

SOLUBILITY OF ALUMINUM CHLORIDE IN AQUEOUS HYDROCHLORIC ACID SOLUTIONS

Results at 0°
(Seidel and Fischer, 1941)

gms. per 100 gms. sat. sol.		
HCl	AlCl_3	Density
0	31.0	..
30.8	1.25	1.16
32.3	0.40	1.17
35.4	0.077	1.19
38.7	0.023	1.20
39.0	0.021	1.20
41.7	0.008	1.22
44.3	0.003	1.23

(see also next page)

Results at 25°
(Malquori, 1927a)

gms. per 100 gms. sat. sol.		Solid Phase
HCl	AlCl_3	
0.0	34.081(?)	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$
4.15	29.75	"
5.09	27.98	"
11.21	18.10	"
14.07	15.25	"
19.43	10.11	"
23.19	7.95	"
30.17	2.49	"
40.98	0.98	"

At 0° 100 cc of a solution saturated with AlCl_3 and HCl at 1 atm. pressure contains 0.0015 gms. Al_2O_3 . (Fischer and Seidel, 1941.)

EQUILIBRIUM IN THE SYSTEM ALUMINUM CHLORIDE-ALUMINUM
FLUORIDE-WATER AT 25°
(Ehret and Frere, 1945)

The composition of the double salt was determined by direct analysis and by algebraic extrapolation of the tie lines.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Cl
AlCl_3	AlF_3	Solid Phase	AlCl_3	AlF_3	Solid Phase	
31.10	0.0	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$	28.58	6.90	D.S.	
30.48	1.50	"	28.47	6.97	D.S. + $\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	
30.37	2.64	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ + D.S.	28.45	7.01	"	
30.21	3.46	"	24.07	6.30	$\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	
30.22	3.46	D.S.	21.04	5.96	"	
29.81	4.37	"	14.33	5.52	"	
29.47	4.93	"	10.68	4.93	"	
28.89	5.62	"	5.50	3.56	"	
28.78	6.03	"	0.0	0.41	"	
28.72	5.46	"				

D.S. = $\text{AlF}_3 \cdot 5\text{AlCl}_3 \cdot 38\text{H}_2\text{O}$

THE SYSTEM ALUMINUM CHLORIDE - ALUMINUM NITRATE - WATER
(Tanaka, 1930)

Results at 0°			Results at 10°		
Gms. per 100 gms. sat. sol.		Solid Phase	gms. per 100 gms. sat. sol.		Solid Phase
AlCl_3	$\text{Al}(\text{NO}_3)_3$		AlCl_3	$\text{Al}(\text{NO}_3)_3$	
30.48	0.0	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$	31.16	0.0	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$
24.45	11.62	"	17.99	20.85	" + $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
19.00	22.65	" + $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	0.0	35.75	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
11.09	30.62	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$			
0.0	43.23	"			

A1 ALUMINUM

THE SYSTEM $\text{AlCl}_3 + 3\text{KNO}_3 \rightleftharpoons \text{Al}(\text{NO}_3)_3 + 3\text{KCl}$ AT 10°
(Tanaka, 1930)

A = KNO_3 B = KCl C = $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ D = $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$

Gms. per 100 gms. sat. sol.					Solid Phase	Gms. per 100 gms. sat. sol.					Solid Phase
$\text{Al}(\text{NO}_3)_3$	AlCl_3	KNO_3	KCl			$\text{Al}(\text{NO}_3)_3$	AlCl_3	KNO_3	KCl		
..	7.80	6.78	11.83	A,B		0.99	19.06	4.66	3.43	A,B	
..	10.68	6.76	8.40	A,B		2.12	20.23	4.17	3.07	A,B	
..	12.94	5.79	6.50	A,B		3.57	21.30	3.51	2.59	A,B	
..	15.83	5.11	5.32	A,B		9.69	24.25	2.79	2.05	A,B,C	
Cl	..	18.67	5.00	3.68	A,B	16.18	20.46	5.17	..	B,C,D	

THE SYSTEM ALUMINUM CHLORIDE-FERRIC CHLORIDE-WATER
(Malquori, 1928(a); at 25° Malquori, 1927(b))

Gms. per 100 gms. sat. sol.				Solid Phase	t°	Gms. per 100 gms. sat. sol.				Solid Phase	t°
FeCl_3	AlCl_3					FeCl_3	AlCl_3				
0	0.0	31.03	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$			25	31.67	7.19	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$		
"	6.37	26.12	"			"	37.88	6.67	"		
"	15.93	17.28	"			"	38.25	5.21	" + $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$		
"	26.30	12.21	" + $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$			"	39.18	5.35	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$		
"	27.40	11.55	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$			"	39.42	5.15	"		
"	31.92	7.81	"			"	43.13	4.00	"		
"	38.12	3.31	"			"	45.25	3.06	"		
"	42.66	0.0	"			"	49.76	0.00	"		
25	0.0	34.08(?)	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$			40	0.0	31.63	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$		
"	8.29	26.02	"			"	17.32	22.70	"		
"	10.34	22.88	"			"	35.78	17.85	"		
"	15.13	19.55	"			"	45.07	14.64	"		
"	18.98	16.72	"			60	0.0	31.73	"		
"	24.78	12.50	"			"	26.31	21.75	"		
"	27.14	9.63	"			"	38.91	17.92	"		

THE SYSTEM $\text{AlCl}_3 - \text{FeCl}_3 - \text{KCl} - \text{H}_2\text{O}$ AT 25°
(Malquori, 1929)

Gms. per 100 gms. Sat. Sol.			Solid Phase
KCl	AlCl_3	FeCl_3	
11.97	0.0	35.88	$\text{KCl} + \text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O}$
2.00	29.21	3.00	" + " : $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$
1.22	0.0	49.33	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ + " : "
6.50	10.80	38.50	" + " + $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$
0.0	5.21	38.25	" + $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$
3.91	30.15	0.0	KCl + "

THE SYSTEM AlCl_3 - FeCl_3 - KCl - HCl - H_2O AT 25°
(Malquori, 1929)

Gms. per 100 gms. sat. sol.					
FeCl_3	AlCl_3	KCl	HCl	Solid Phase	
0.0	0.09	1.18	33.21	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{KCl}$	
3.00	29.21	2.00	0.0	" + " + $\text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O}$	
0.98	0.25	1.87	38.25	" + " + "	
1.15	0.0	1.50	39.20	" + "	
38.50	10.80	6.50	0.0	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O} + \text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O}$	
69.91	1.31	1.01	11.00	$\text{FeCl}_3 \cdot 2\text{H}_2\text{O} +$ " + " + $\text{FeCl}_3 \cdot \text{HCl} \cdot 2\text{H}_2\text{O}$	
69.81	1.02	0.0	11.75	" + " + $\text{FeCl}_3 \cdot \text{HCl} \cdot 2\text{H}_2\text{O}$	
70.10	0.0	1.71	11.85	" + $\text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O} +$ "	

EQUILIBRIA IN THE SYSTEM AlCl_3 - FeCl_3 - NaCl - KCl - HCl - H_2O
(G. L. Miles, 1947)

Gms. per 100 gms. sat. sol.							
Temp.	HCl	FeCl_3	KCl	AlCl_3	NaCl	Solid Phases	
25°	26.1	3.90	1.39	3.38	N.D.	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + \text{KCl} + 2\text{KCl} \cdot \text{FeCl}_3 \cdot \text{H}_2\text{O}$	
	26.8	4.55	1.31	2.62	N.D.	"	
	27.1	2.26	1.77	2.60	0.30	"	
	27.9	2.38	1.58	2.51	N.D.	"	
	28.0	2.30	1.64	2.38	N.D.	"	
	28.4	nil	1.47	2.49	N.D.	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + \text{KCl}$	
	31.7	nil	1.38	N.D.	N.D.	"	
	32.4	nil	1.42	N.D.	N.D.	"	
	36.5	1.33	1.44	0.16	0.11	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + \text{KCl} + 2\text{KCl} \cdot \text{FeCl}_3 \cdot \text{H}_2\text{O}$	
30°	21.3	2.80	2.14	7.45	0.49	"	
	21.3	2.82	2.21	7.49	.49	"	
	25.9	2.55	1.87	3.92	N.D.	"	
	26.0	2.58	1.93	3.65	N.D.	"	
	29.0	2.34	1.63	1.70	0.29	"	
	29.98	nil	1.65	1.83	0.34	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + \text{KCl}$	
	29.92	nil	1.68	1.88	.35	"	
	29.9	0.20	1.66	1.91	.36	"	
	29.8	.98	1.65	1.52	N.D.	"	
	29.1	1.18	1.69	2.02	0.34	"	
	29.8	1.74	1.68	1.05	N.D.	"	
	28.6	3.60	1.42	1.58	0.28	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + 2\text{KCl} \cdot \text{FeCl}_3 \cdot \text{H}_2\text{O}$	
	28.6	3.84	1.38	1.60	N.D.	"	
	28.5	3.99	1.41	1.49	0.28	"	
	30.6	2.08	1.51	0.85	.20	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O} + \text{NaCl} + \text{KCl} + 2\text{KCl} \cdot \text{FeCl}_3 \cdot \text{H}_2\text{O}$	
	34.3	1.73	1.50	.32	.18	"	
	35.9	1.62	1.52	.25	.14	"	
	36.7	1.51	1.55	.20	.13	"	
	38.0	1.38	1.62	.18	.13	"	

N.D. = Not determined.

(Cont.)

A1 ALUMINUM

Temp.	Gms. per 100 gms. sat. sol.					Solid Phases
	HCl	FeCl ₃	KCl	AlCl ₃	NaCl	
35°	25.7	2.88	2.01	3.61	.42	AlCl ₃ ·6H ₂ O+NaCl+KCl+2KCl·FeCl ₃ ·H ₂ O
	30.8	2.44	1.74	0.93	.27	"
	32.7	2.23	1.71	.47	.25	"
	36.0	1.93	1.77	.18	.18	"

C1 THE SYSTEM ALUMINUM CHLORIDE - POTASSIUM CHLORIDE - WATER (Tanaka, 1930 at 0°, 10°; Malquori, 1927 at 25°)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
KCl	AlCl ₃	Solid Phase	KCl	AlCl ₃	Solid Phase
Results at 0°			Results at 25°		
21.46	0.0	KCl	0.0	34.08(?)	AlCl ₃ ·6H ₂ O
11.96	8.20	"	2.15	33.18	" + KCl
5.01	16.39	"	3.91	30.15	KCl
2.88	23.18	"	7.80	24.09	"
1.81	30.64	KCl + AlCl ₃ ·6H ₂ O	9.03	19.81	"
0.0	30.48	AlCl ₃ ·6H ₂ O	10.51	12.28	"
Results at 10°			13.98	7.93	"
			17.93	4.07	"
			26.31	0.0	"
23.7	0.0	KCl			
5.52	17.15	"			
2.27	30.13	KCl + AlCl ₃ ·6H ₂ O			
0.0	31.16	AlCl ₃ ·6H ₂ O			

THE SYSTEM AlCl₃ - KCl - HCl - H₂O (Malquori, 1927b)

Solid phase AlCl₃·6H₂O + KCl throughout

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
AlCl ₃	KCl	HCl	AlCl ₃	KCl	HCl
Results at 0°			Results at 40°		
30.25	1.93	0.0	30.28	4.35	0.0
21.32	0.91	8.72	21.33	3.10	8.03
6.91	0.13	22.97	2.31	1.51	27.70
1.49	0.60	30.12	0.60	0.93	31.25

(Cont.)

Solid phase $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ + KCl throughout

gms. per 100 gms. sat. sol.			gms. per 100 gms. sat. sol.		
AlCl_3	KCl	HCl	AlCl_3	KCl	HCl
Results at 25°			Results at 60°		
30.15	3.91	0.0	30.85	4.96	0.0
29.28	2.67	1.19	12.51	2.57	15.91
23.50	2.37	3.27	4.39	2.35	26.61
19.31	1.15	9.74	0.11	1.34	33.7
18.15	0.85	10.09			
16.37	0.79	13.93	Results at 80°		
13.47	0.82	15.87			
6.78	0.51	22.07	31.15	5.12	0.0
1.11	0.85	31.56	15.34	3.92	11.28
0.17	1.03	31.97	7.91	2.08	23.04
0.09	1.18	33.21	5.23	2.88	27.31

SOLUBILITY OF ALUMINUM CHLORIDE IN AQUEOUS SOLUTIONS OF
URETHAN AND VICE VERSA AT 25°
(Palitzsch, 1928, 1929)

Gm. mols. per 1000 gms. H_2O		Solid Phase	Gm. mols. per 100 gms. H_2O		Solid Phase
AlCl_3	$\text{NH}_2\text{COOC}_2\text{H}_5$		AlCl_3	$\text{NH}_2\text{COOC}_2\text{H}_5$	
3.38	0.0	$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$	2.02	1.778	$\text{NH}_2\text{COOC}_2\text{H}_5$
3.38	1.466	"	1.04	6.544	"
3.39	1.554	" + $\text{NH}_2\text{COOC}_2\text{H}_5$	0.0	53.09	"
2.96	1.480	$\text{NH}_2\text{COOC}_2\text{H}_5$			

At 0° 100 cc of a mixture of equal volumes of ethyl ether and water saturated with AlCl_3 and HCl at 1 atm. pressure contains 0.0003 g. Al_2O_3 .
- Fischer and Seidel, 1941.

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS

t°	gms. AlCl_3 per 100 gms. sat. sol.	t°	gms. AlCl_3 per 100 gms. sat. sol.
In Benzene (1)(8)		In Benzene (1)(8)	
17	0.12 ? (1)	145.1	30.03
18	0.72 ? (1)	151.8	40.50
108.6	4.88	155.3	47.83
111.3	5.84	160.9	57.18
127.3	13.66	192.0	100.0
136.0	19.86		

(1) Menshutkin, 1909a

(8) Eley and King, 1951

AL ALUMINUM

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlCl ₃ per 100 gms. sat. sol.	Solid Phase
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In Benzene-ether solutions

Freezing point depressions are given by (2)

<u>In Benzophenone (3)</u>		
48 m. pt.	0	(C ₆ H ₅) ₂ CO
44	8.5	"
39.5 Eutec.	15.4	" + AlCl ₃ ·(C ₆ H ₅) ₂ CO
60	19.3	AlCl ₃ ·(C ₆ H ₅) ₂ CO
90	26.5	"
120	37.0	"
130 m. pt.	42.3	"
110	48.8	"
80	53.5	"
60 Eutec.	56.1	" + AlCl ₃
100	58.0	AlCl ₃
140	63.0	"
160	68.6	"
180	78.5	"
190	89.1	"
192	93.0	"
194	100	"

In Benzoyl Chloride (3)

-0.5 m. pt.	0	C ₆ H ₅ COCl
-4	7.9	"
-7.5 Eutec.	12.7	" + AlCl ₃ ·C ₆ H ₅ COCl
0	14.1	AlCl ₃ ·C ₆ H ₅ COCl
20	18.8	"
40	25.0	"
60	33.0	"
80	42.2	"
93 m. pt.	48.7	"
80	52.9	"
60	57.2	"
40	61.0	"

- (2) Gorenbein, Pivnutel and Gersun, 1953
 (3) Menshutkin, 1909

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlCl ₃ per 100 gms. sat. sol.	Solid Phase
<u>In o-Bromonitrobenzene (3)</u>		
38.5	0	<u>o</u> C ₆ H ₄ BrNO ₂
32	7.5	"
26	13.1	"
20 Eutec.	17.5	" + AlCl ₃ · <u>o</u> C ₆ H ₄ BrNO ₂
40	21.7	AlCl ₃ · <u>o</u> C ₆ H ₄ BrNO ₂
60	26.4	"
80	31.7	"
97 m. pt.	38.0	"
100	39.8	"
90	44.6	"
80 Eutec.	46.5	" + AlCl ₃
110	50.1	AlCl ₃
130	54.1	"
150	60.2	"
170	70.0	"
180	77.4	"
<u>In m-Bromonitrobenzene (3)</u>		
54.7	0	<u>m</u> C ₆ H ₄ BrNO ₂
51	6.5	"
47 Eutec.	11.9	" + AlCl ₃ · <u>m</u> C ₆ H ₄ BrNO ₂
60	16.0	AlCl ₃ · <u>m</u> C ₆ H ₄ BrNO ₂
80	22.9	"
100	30.7	"
110	35.9	"
116 m. pt.	39.8	"
113	42.3	"
107	44.5	"
97 Eutec.	47.4	" + AlCl ₃
120	51.5	AlCl ₃
140	56.5	"
160	64.5	"
180	77.4	"
190	88.8	"
197	100	"

(3) Menshutkin, 1909

Al ALUMINUM

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

		gms. AlCl_3 per 100 gms. sat. sol.	Solid Phase
<u>In p-Bromonitrobenzene (3)</u>			
Cl	124.5 m. pt.	0	$\text{pC}_6\text{H}_4\text{BrNO}_2$
	117	7.4	"
	111	12.8	"
	105	17.7	"
	99 Eutec.	22.2	" + $\text{AlCl}_3 \cdot \text{pC}_6\text{H}_4\text{BrNO}_2$
	120	28.4	$\text{AlCl}_3 \cdot \text{pC}_6\text{H}_4\text{BrNO}_2$
	140	36.4	"
	145 m. pt.	39.8	"
	140	44.5	"
	120	51.2	"
	113 Eutec.	52.8	" + AlCl_3
	130	55.9	AlCl_3
	150	61.3	"
	180	77.4	"
	190	88.8	"
	194	100.0	"
<u>In Carbon Tetrachloride (4)</u>			
	4	0.74 gms. per liter sat. sol.	
	14	0.22 "	
	20	0.15 "	
	34	0.06 "	
<u>In Chloroform (4)</u>			
	-15	0.65 gms. per liter sat. sol.	
	0	1.0 "	
	25	0.72 "	
<u>In o-Chloronitrobenzene (3)</u>			
	32.5 m. pt.	0	$\text{oC}_6\text{H}_4\text{ClNO}_2$
	27	10.2	"
	21	16.1	"
	15 Eutec.	20.3	" + $\text{AlCl}_3 \cdot \text{oC}_6\text{H}_4\text{ClNO}_2$
	35	25.5	$\text{AlCl}_3 \cdot \text{oC}_6\text{H}_4\text{ClNO}_2$
	55	31.5	"
	75	38.7	"
	89 m. pt.	45.9	"
	80	51.0	"
	69 Eutec.	54.4	" + AlCl_3
	110	57.5	AlCl_3
	150	65.4	"
	175	74.6	"
	194	100	"

(3) Menshutkin, 1909

(4) Lloyd, 1918

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlCl ₃ per 100 gms. sat. sol.	Solid Phase
<u>In m-Chloronitrobenzene (3)</u>		
44.5 m. pt.	0	$\underline{m}C_6H_4ClNO_2$
44	10.7	"
36 Eutec.	16.6	" + AlCl ₃ · $\underline{m}C_6H_4ClNO_2$
50	21.0	AlCl ₃ · $\underline{m}C_6H_4ClNO_2$
70	28.3	"
90	36.8	"
104 m. pt.	45.9	"
90	52.4	"
81 Eutec.	55.6	" + AlCl ₃
120	60.0	AlCl ₃
140	64.1	"
160	70.2	"
<u>In p-Chloronitrobenzene (3)</u>		
83.5 m. pt.	0	$\underline{p}C_6H_4ClNO_2$
78	7.1	"
73	12.8	"
68 Eutec.	17.1	" + AlCl ₃ · $\underline{p}C_6H_4ClNO_2$
80	22.2	AlCl ₃ · $\underline{p}C_6H_4ClNO_2$
100	31.4	"
120	41.8	"
126 m. pt.	45.9	"
110	53.2	"
94 Eutec.	58.1	" + AlCl ₃
125	60.5	AlCl ₃
155	66.9	"
180	77.7	"
190	88.2	"
194	100	"
<u>In Diethyl ether See (7)</u>		

(3) Menshutkin, 1909

(7) Plotnikov and Kaplan, 1948

A1 ALUMINUM

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

	gms. AlCl_3 per 100 gms. sat. sol.	Solid Phase
<u>In Nitrobenzene (3)(5)</u>		
5.5 m. pt.	0	$\text{C}_6\text{H}_5\text{NO}_2$
2 Eutec.	10.3	" + $\text{AlCl}_3 \cdot 2\text{C}_6\text{H}_5\text{NO}_2$
15	18	$\text{AlCl}_3 \cdot 2\text{C}_6\text{H}_5\text{NO}_2$
25.5 Eutec.	30.5	" + $\text{AlCl}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$
45	34.2	$\text{AlCl}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$
65	39.5	"
85	48	"
90 m. pt.	52	"
82	55.6	"
72	58	"
52 Eutec.	61.6	" + AlCl_3
90	64	AlCl_3
130	67.7	"
160	72.4	"
180	80.1	"
194	100	"

In Nitrobenzene solutions containing acetamide

Freezing point lowerings are given by (5)

In Nitrobenzene + NH₄Cl andNitrobenzene + NH₄Br

Cryoscopic studies (6)

In o-Nitrotoluene (3)

-8.5 m. pt.	0	<u>o</u> -C ₆ H ₄ CH ₃ NO ₂
-9.3 Eutec.	1	" + AlCl ₃ ·2 <u>o</u> -C ₆ H ₄ CH ₃ NO ₂
0	1	5AlCl ₃ ·2 <u>o</u> -C ₆ H ₄ CH ₃ NO ₂
20	4	"
40	11	"
55 Eutec.	31	" + AlCl ₃ · <u>o</u> -C ₆ H ₄ CH ₃ NO ₂
85	41.8	AlCl ₃ · <u>o</u> -C ₆ H ₄ CH ₃ NO ₂
95.5 m. pt.	49.3	"
70	56.8	"
45 Eutec.	61.5	" + AlCl ₃
95	64.5	AlCl ₃
145	73.7	"
180	86.2	"
185	89.5	"
194	100	"

(3) Menshutkin, 1909

(5) Rabinovich and Ponomarenko, 1953

(6) Smolentsev, 1953

SOLUBILITY OF ALUMINUM CHLORIDE IN ORGANIC SOLVENTS--Contd.

t°	gms. AlCl ₃ per 100 gms. sat. sol.	Solid Phase
<u>In m-Nitrotoluene (3)</u>		
16 m. pt.	0	$\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
13 Eutec.	7.8	" + AlCl ₃ · 2 $\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
27	13.4	AlCl ₃ · 2 $\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
35 Eutec.	24.5	" + AlCl ₃ · $\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
65	34.0	AlCl ₃ · $\text{mC}_6\text{H}_4\text{CH}_3\text{NO}_2$
90	44.2	"
95	46.7	"
99.5 m. pt.	49.3	"
70	56.8	"
45 Eutec.	61.5	" + AlCl ₃
95	64.5	AlCl ₃
120	68.2	"
130	70.2	"
<u>In p-Nitrotoluene (3)</u>		
52.5 m. pt.	0	$\text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
47	9.2	"
42	15.0	"
37 Eutec.	19.0	" + AlCl ₃ · $\text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
55	29.1	AlCl ₃ · $\text{pC}_6\text{H}_4\text{CH}_3\text{NO}_2$
80	34.8	"
95	41.3	"
109 m. pt.	49.3	"
100	53.4	"
60	61.7	"
45 Eutec.	64.0	" + AlCl ₃
105	69.5	AlCl ₃
165	80.0	"
190	94.3	"
194	100.0	"
<u>In Toluene (1)</u>		
17	0.26	
73	0.92	

(1) Menschutkin, 1909a

(3) Menachutkin, 1909

Al ALUMINUM

THE SYSTEM ALUMINUM CHLORIDE - IODINE MONOCHLORIDE (Fialkov and Shop, 1949)

	mole %		Solid Phase	t°	mole %		Solid Phase
	AlCl ₃						
Cl	27.0	0.0	ICl	110	36.51	2ICl·AlCl ₃	
	24.0	2.49	"	110	38.16	"	
	21.5	4.87	"	108	40.55	"	
	13.5	7.82	"	105	42.14	2ICl·AlCl ₃ + AlCl ₃	
	7.0	10.59	"	132	46.56	AlCl ₃	
	2.0	13.31	ICl + 2ICl·AlCl ₃	138	51.61	"	
	4.5	13.98	2ICl·AlCl ₃	155	40.49	"	
	9.0	15.88	"	170	69.50	"	
	23.5	18.19	"	178	80.45	"	
	32.0	20.30	"	186	90.71	"	
	100.0	28.55	"				

SOLUBILITY OF ALUMINUM CHLORIDE IN:

Hydrazine (Welsh and Broderson, 1915)

1.0 gm. dissolve in 100 cc at room temperature.

Hydrogen Chloride (Richardson and Benson, 1951)

At -78°, 3.9 ± 0.9 mole % AlCl₃ dissolve in a "water clear" phase of anhydrous HCl.

Titanium Tetrachloride (Eingorn, 1950)

t°	mole % AlCl ₃	t°	mole % AlCl ₃	t°	mole % AlCl ₃
-23.1	0.0*	-12.2	3.8	113.9	22.8
-24.0	0.8**	92.9	8.1	120.0	30.3
-20.5	2.0	109.6	16.3		

*Solid phase TiCl₄

** " " TiCl₄ + AlCl₃

Melting point data are given for the following:

$\text{AlCl}_3 + \text{AgCl}$ (1)	$\text{AlCl}_3 + \text{NaCl}$ (1)(2)(3)(4)(5)
+ BaCl_2 (1)	+ PCl_5 (6)
+ CuCl (1)	+ SbCl_3 (1)
+ HgCl (1)	+ SeCl_4 (7)
+ HgCl_2 (1)	+ SnCl_2 (1)
+ KCl (1)(2)(3)	+ SnCl_4 (1)
+ LiCl (1)	+ TeCl_4 (7)
+ MgCl_2 (1)	+ TiCl_4 (9)
+ MnCl_2 (1)	+ TlCl (1)
+ NH_4Cl (1)	+ $\text{KCl} + \text{NaCl}$ (8)

(1) Kendall, Crittenden and Miller, 1923; (2) Starokadomskaya, 1939; (3) Shvartsman, 1940; (4) Chretien and Laus, 1943; (5) Houtgraaf and Roos, 1953; (6) Fialkov and Bur'yanov, 1953; (7) Houtgraaf, Rang and Vollbracht, 1953; (8) Midorikawa, 1955; (9) Eingorn, 1950a.

-Conductivities (1941), and densities (1942) for the system $\text{AlCl}_3\text{-SO}_2$ (liquid) are given by Tesei, 1942.

-The system $\text{AlCl}_3\text{-ICl-C}_6\text{H}_5\text{NO}_2$ was studied by electrolysis and transference by Fialkov and Kaganckav, 1948.

-Conductivities and specific gravities in the system $\text{AlCl}_3 + \text{ICl}$ are given by Fialkov and Shor (1949a).

-The system $\text{AlCl}_3 + \text{ICl} + \text{C}_6\text{H}_5\text{NO}_2$ was studied electrically by Fialkov and Kazanekai, 1948.

-The system $\text{AlCl}_3 + 3\text{Na} \rightleftharpoons 3\text{NaCl} + \text{Al}$ was studied at 825° by Jander and Herrman (1938).

-The system $2\text{AlCl}_3 + 3\text{Zn} \rightleftharpoons 3\text{ZnCl}_2 + 2\text{Al}$ was studied at $550^\circ - 600^\circ$ by Delimarskii and Berenblyum (1940).

-The system $2\text{AlCl}_3 + 3\text{Ca} \rightleftharpoons 3\text{CaCl}_2 + 2\text{Al}$ was studied at 800° by Lorenz and Schulz (1928).

-The system $2\text{AlCl}_3 + 3\text{Mg} \rightleftharpoons 3\text{MgCl}_2 + 2\text{Al}$ was studied at 700° by Lorenz and Schulz (1928).

ALUMINUM PERCHLORATE $\text{Al}(\text{ClO}_4)_3$

ClO

SOLUBILITY IN WATER (Dobrosedow and Erdmann, 1926)

t°	Gms. $\text{Al}(\text{ClO}_4)_3$ per 100 gms. sat. sol.	Solid Phase
0	54.87	$\text{Al}(\text{ClO}_4)_3 \cdot 9\text{H}_2\text{O}$
14.3	56.68	"
91.5	64.62	"

A1 ALUMINUM

SOLUBILITY OF ALUMINUM PERCHLORATE IN AQUEOUS SOLUTIONS OF AMMONIUM PERCHLORATE AND OF SODIUM PERCHLORATE AT 30° AND VICE VERSA (Craven and Bryce, 1934)

Results for Ammonium Perchlorate

Gms. per 100 gms. H ₂ O		Solid Phase
NH ₄ ClO ₄	Al(ClO ₄) ₃	
0.0	110.1	Al(ClO ₄) ₃ ·aq.
0.91	107.7	" + NH ₄ ClO ₄
2.36	55.69	NH ₄ ClO ₄
8.59	26.19	"
13.15	17.47	"
18.66	9.77	"
23.10	5.25	"
25.63	3.13	"
28.00	0.00	"

Results for Sodium Perchlorate

Gms. per 100 gms. H ₂ O		Solid Phase
NaClO ₄	Al(ClO ₄) ₃	
0.0	110.1	Al(ClO ₄) ₃ ·aq
30.02	83.87	"
43.84	76.26	" + NaClO ₄ ·H ₂ O
50.64	72.46	NaClO ₄ ·H ₂ O
100.7	45.59	"
116.6	37.30	"
135.4	27.76	"
215.0	0.0	"

C10 ALUMINUM Hexa Antipyrine PERCHLORATE [Al(COC₁₀H₁₂N₂)₆] (ClO₄)₃

100 cc. sat. solution in water (d₂₅/4 = 1.3497) contain 1.09 gm. Al(COC₁₀H₁₂N₂)₆ (ClO₄)₃ at 20°. (Wilke/Dorfurt and Schliephake, 1929.)

F ALUMINUM FLUORIDE AlF₃

SOLUBILITY IN WATER

Six different hydrates have been reported. Yatlov and Pinaevskaya, 1946 found AlF₃·3H₂O (stable at all temperatures studied), α-AlF₃·3.5H₂O, β-AlF₃·3.5H₂O, and AlF₃·9H₂O. There is a transition between the metastable 9 and β-3.5 hydrates at about 8°. Refractive indices of the solutions are also given. Ehret and Frere, 1945 also report the trihydrate. Nikolaev, Ivanov, and Koltypin, 1936 found AlF₃·2.5H₂O, while Tananaev, 1938 lists data for AlF₃·H₂O. Carter, 1928 does not give the composition of the solid phase.

The solubility curves of the 3 and α-3.5 hydrates are parallel. That of the 2.5 hydrate differs only slightly and intersects them with a slope which would make AlF₃·2.5H₂O the stable phase below about 30°. This highly unusual situation (cooling producing a stable hydrate containing less water) may indicate that the data are unreliable.

Solid Phase:	gms. AlF_3 per 100 gms. sat. sol.						$\text{AlF}_3 \cdot \text{H}_2\text{O}$
	$\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	$\alpha \text{AlF}_3 \cdot 3.5\text{H}_2\text{O}$	$\beta \text{AlF}_3 \cdot 3.5\text{H}_2\text{O}$	$\text{AlF}_3 \cdot 9\text{H}_2\text{O}$	$\text{AlF}_3 \cdot 2.5\text{H}_2\text{O}$		
t°							
0	0.25	0.56	2.62	0.97	0.128 ¹	-	-
5	-	-	-	1.65	-	-	-
8	-	-	2.26	2.19	-	-	-
10	0.28	0.56	2.31	2.81	-	-	-
15	-	-	-	3.52	-	-	-
20	-	-	-	-	0.499 ²	-	-
25	0.50 (0.41)††	0.71	2.70	5.10	-	0.55 (0.559)**	-
30	-	-	-	-	0.61 ³	-	F
50	-	1.04	5.44	9.45	0.81 ⁴	-	-
66	-	-	-	-	1.32	-	-
75	0.88	1.27	7.11	-	-	-	-
90	1.17	-	-	-	-	-	-
100	1.64*	1.72†	-	-	-	-	-
102	-	-	-	-	2.41	-	-

*Boiling pt. at 745 mm.

**gms. per 100 cc. sat. soln.; pH = 5.2 (Carter, 1928)

¹⁻⁴densities referred to water at 4°: ¹1.0018; ²1.0051; ³1.0071; ⁴1.0078

†Boiling pt. at 735 mm.

††Ehret and Frere, 1945

SOLUBILITY OF ALUMINUM FLUORIDE IN HYDROFLUORIC ACID SOLUTIONS (Nikolaev, Ivanov, and Koltypin, 1936; Tananaev, 1938)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
HF	AlF ₃			HF	AlF ₃		
Results at about 20°(N.I.&K.)							
(18°)	0.53	0.81	AlF ₃ ·2.5H ₂ O	(20°)	5.0	2.5	AlF ₃ ·2.5H ₂ O
(19°)	0.67	0.85	"	(20°)	9.6	2.6	"
(17.5°)	1.48	0.92	"	(20°)	14.4	3.2	"
(18°)	1.56	0.93	"	(20°)	36.3	4.4	"
(18.5°)	3.1	1.19	"				

(Cont.)

A1 ALUMINUM

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HF	AlF ₃		HF	AlF ₃	
Results at 25° (T.)					
0.0	0.55	AlF ₃ ·H ₂ O	34.07	13.63	1.3.6
0.77	0.39	"	36.13	13.44	"
2.00	1.56	"	37.08	14.18	"
4.96	2.74	"	37.81	17.07	"
10.44	5.37	"	39.01	16.08	1.3.3
17.77	9.58	"	41.00	14.03	"
21.08	16.63	"	42.45	12.96	"
22.94	19.00	"	46.88	10.43	"
26.30	19.68	1.3.6	51.80	7.15	"
27.64	19.68	"	54.03	6.18	"
28.90	14.84	"	57.57	5.04	"
30.66	12.52	"	60.83	4.00	"
31.07	13.42	"	62.73	3.53	"
31.90	13.21	"			

(1:3:6 = AlF₃·3HF·6H₂O; 1:3:3 = AlF₃·3HF·3H₂O)

Results at 40° (N.I. & K.)					
1.0	1.25	AlF ₃ ·2.5H ₂ O	7.4	3.8	AlF ₃ ·2.5H ₂ O
2.9	2.07	"	14.3	4.25	"
4.8	3.0	"	36	4.9	"

Results at 60° (N.I. & K.)					
1.0	1.30	AlF ₃ ·2.5H ₂ O	7.6	3.9	AlF ₃ ·2.5H ₂ O
2.9	2.2	"	14.9	4.4	"
5.1	3.2	"	36	5.0	"

THE SYSTEM ALUMINUM FLUORIDE-ALUMINUM NITRATE-WATER AT 25° (Ehret and Frere, 1945)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Al(NO ₃) ₃	AlF ₃		Al(NO ₃) ₃	AlF ₃	
39.43	0.0	Al(NO ₃) ₃ ·9H ₂ O	31.05	5.29	AlF ₃ ·3H ₂ O
38.83	1.17	"	24.47	5.20	"
38.53	2.65	"	19.46	5.09	"
38.33	3.95	"	15.20	4.51	"
37.92	5.17	"	10.79	3.99	"
37.92	5.35	Al(NO ₃) ₃ ·9H ₂ O	5.78	2.78	"
		+ AlF ₃ ·3H ₂ O	0.0	0.41	"
37.88	5.41	"			

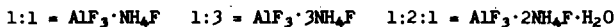
THE SYSTEM ALUMINUM FLUORIDE-ALUMINUM SULFATE-WATER AT 25°
(Ehret and Frere, 1945)

The composition of the double salt was found by both algebraic extrapolation and direct analysis.



Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	
$\text{Al}_2(\text{SO}_4)_3$	AlF_3		$\text{Al}_2(\text{SO}_4)_3$	AlF_3		
28.22	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$	17.82	4.60	1:1:15	F
28.52	0.74	" + 1:1:15	17.45	5.33	"	
28.63	0.80	1:1:15	17.10	5.98	" + $\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	
26.61	1.18	"	14.97	5.51	$\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	
24.85	1.47	"	10.00	4.46	"	
22.55	1.93	"	6.18	3.43	"	
20.07	3.05	"	0.0	0.41	"	
18.95	3.75	"				

THE SYSTEM ALUMINUM FLUORIDE-AMMONIUM FLUORIDE-WATER AT 25°
(Novosselova, 1940)



Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
AlF_3	NH_4F		AlF_3	NH_4F	
0.55	..	$\text{AlF}_3 \cdot 3\text{H}_2\text{O}$	0.21	0.71	1:2:1
.46	0.10	"	.16	.73	1:2:1
.57	.13	"	.17	.82	1:2:1 + 1:3
.62	.14	$\text{AlF}_3 + 1:1$	.062	1.02	1:3
.26	.18	1:1	.022	1.44	1:3
.22	.30	1:1	.012	4.39	1:3
.42	.61	1:1 + 1:2:1			
.26	.65	1:2:1			

SOLUBILITY OF $\text{Al}(\text{NH}_4)_3\text{F}_6$ IN WATER
(Tananaev and Talipov, 1939; Carter, 1930)

t°	Gms. $\text{Al}(\text{NH}_4)_3\text{F}_6$ per 1000 gms. sat. sol.	t°	Gms. $\text{Al}(\text{NH}_4)_3\text{F}_6$ per 1000 gms. sat. sol.
0°	4.3128	60°	11.7034
(20°	10.3) (Carter)	65°	11.2510
25°	7.6585	75°	11.0132
50°	12.3622	100°	7.4190
55°	12.1217		

A1 ALUMINUM

THE SYSTEM ALUMINUM FLUORIDE-POTASSIUM FLUORIDE-WATER AT 25° (Tananaev and Nekhamkina, 1950)

Gms. per liter sat. sol.			gms. per liter sat. sol.		
KF	AlF ₃	Solid Phase	KF	AlF ₃	Solid Phase
0.852	1.588	AlF ₃ ·2KF·H ₂ O	4.985	Trace	AlF ₃ ·2KF·H ₂ O
0.7592	0.6128	"	8.0	"	"
1.075	0.1153	"	11.145	"	AlF ₃ ·2.3KF (?)
1.328	0.026	"	13.782	"	AlF ₃ ·2.4KF (?)
2.385	0.042	"	17.228	"	AlF ₃ ·2.7KF (?)
2.488	0.006	"	24.244	"	AlF ₃ ·3KF
3.732	Trace	"	37.336	"	"
			50.6	"	"

SOLUBILITIES OF ALUMINUM POTASSIUM FLUORIDES

Solubility of AlF ₃ ·3KF in Water (Tananaev and Talipov, 1939)		Solubility of AlF ₃ ·2KF·H ₂ O in Aqueous HF Solutions at 25° (Tananaev and Nekhamkina, 1950)		
t°	gms. AlF ₃ ·3KF per 100 gms. sat. sol.	% HF in solvent	% AlF ₃ ·2KF·H ₂ O in sat. sol.	Solid Phase
0	0.08604	0	0.1278	AlF ₃ ·2KF·H ₂ O
25	0.14288	1	0.1312	"
50	0.26125	2	0.1493	"
75	0.34511	5	0.1759	"
100	0.45828	10	0.4561	"
		20	1.1938	"
		30	4.10	"
		43	9.80	AlF ₃ ·3KF

THE SYSTEM ALUMINUM FLUORIDE-SODIUM FLUORIDE-WATER

Results at 25°
(Tananaev and Lelchuk, 1943)

The authors claim that cryolite as found in nature or prepared in the laboratory is not AlF₃·3NaF but 4AlF₃·11NaF. Both phases were found in the system, the former incongruently soluble and the latter congruently soluble.

Weight %				Solid Phase
Solution		Solid Phase		
NaF	AlF ₃	NaF	AlF ₃	
0.039	0.303	11.16	8.25	4AlF ₃ ·11NaF
.038	.149	8.59	6.25	"
.037	.071	15.20	11.20	"
.118	.059	13.70	10.21	"
.178	.0062	14.62	10.61	"
.274	.0021	15.55	11.63	"
.880	.0009	23.73	17.44	"
1.28	.0010	12.17	8.72	"
1.39	..	19.55	13.41	4AlF ₃ ·11NaF + AlF ₃ ·3NaF
2.32	..	15.31	10.31	AlF ₃ ·3NaF
3.52	..	25.96	17.31	"
3.76	..	25.14	16.64	"

Results at 75°
(Yatlov and Pinaevskaya, 1949)

The authors found five stable phases in the system: AlF₃·3H₂O, solid solutions of AlF₃·3H₂O in chiolite, chiolite, solid solutions of chiolite in NaF, and NaF. The chiolite corresponded to the compound 3NaF·2AlF₃, which is found in the binary system, instead of the naturally occurring 5NaF·2AlF₃. The solid solutions of chiolite in NaF showed no indication of the presence of 11NaF·4AlF₃, but the upper solubility limit of the solids had a ratio Na:Al of 2.7 - 2.8.

Saturated Solution		Solid Phase				
% AlF ₃	% NaF	% F	% Al	% Na	(Na) (Al)	Identity
0.89	0	40.91	19.85	...	..	AlF ₃ ·3H ₂ O
.90	0.038	41.17	19.99	...	..	"
.93	.032	49.81	20.84	10.94	0.63	"
.86	.032	52.78	20.36	15.24	.88	"
.80	.033	...	20.00	15.25	.90	"
.75	.038	56.00	19.67	22.40	1.34	Chiolite
.72	.049	55.60	18.33	24.20	1.55	Cryolite
.50	.046	55.05	18.30	24.65	1.58	Chiolite
.28	.035	55.07	18.27	24.31	1.56	"
.143	.033	55.50	18.10	23.75	1.54	"
.093	.048	55.50	18.36	24.10	1.55	"
.014	.051	54.71	16.72	27.27	1.92	AlF ₃ ·3H ₂ O + NaF
.016	.073	53.60	15.82	28.36	2.14	Chiolite
.0105	.060	53.44	14.55	30.32	2.44	AlF ₃ ·3H ₂ O + NaF
.006	.082	54.20	13.85	32.40	2.84	Chiolite
0	.40	53.10	14.41	32.62	2.66	"
0	.88	53.40	14.18	32.00	2.66	"
0	1.83	53.30	13.60	32.05	2.70	"
0	2.62	52.822	13.84	31.80	2.69	"
0	3.86	53.66	13.65	32.08	2.75	"
0	4.05	53.02	13.68	32.38	2.78	Cryolite

A1 ALUMINUM

SOLUBILITY OF $\text{AlF}_3 \cdot 3\text{NaF}$ IN WATER

(Tananaev and Talipov, 1939)		(Buchwald, 1939)	
Temp.	Gms. AlNa_3F_6 per 1000 gms. sat. sol.	Temp.	Gms. AlNa_3F_6 per liter of sat. sol.
0°	0.3480	0°	0.30
25°	.4175	18°	.358
50°	.40 (Frere, 1936)	25°	.391
75°	.9302	37°	.46
100°	1.3500	95°	.75

F SOLUBILITY OF ALUMINUM SODIUM FLUORIDE IN AQUEOUS SALT SOLUTIONS AT 25° (Frere, 1936)

Results for:

<u>Aluminum Nitrate</u> Mols. per 1000 mols. H_2O		<u>Aluminum Chloride</u> Mols. per 1000 mols. H_2O		<u>Aluminum Sulfate</u> Mols. per 1000 mols. H_2O	
$2[\text{Al}(\text{NO}_3)_3]$	AlNa_3F_6	Al_2Cl_6	AlNa_3F_6	$\text{Al}_2(\text{SO}_4)_3$	AlNa_3F_6
0.0	0.034	0.50	0.66	0.40	0.56
0.49	0.65	1.02	1.14	0.74	0.87
0.96	1.11	3.23	2.94	1.56	1.59
3.05	2.91	5.12	4.12	3.33	2.84
5.09	4.37	7.22	5.39	5.08	4.02
10.03	7.72	9.25	6.57	7.59	5.54
12.12	9.01	12.03	7.92	10.50	7.13
14.37	10.62	15.27	9.53	13.72	8.63
19.76	14.36	20.28	11.41	17.04	10.60

<u>Ferric Nitrate</u> Mols. per 1000 mols. H_2O		<u>Ferric Chloride</u> Mols. per 1000 mols. H_2O		<u>Ferric Sulfate</u> Mols. per 1000 Mols. H_2O	
$2[\text{Fe}(\text{NO}_3)_3]$	AlNa_3F_6	$2(\text{FeCl}_3)$	AlNa_3F_6	$\text{Fe}_2(\text{SO}_4)_3$	AlNa_3F_6
0.99	0.81	1.00	0.73	1.02	0.58
3.09	1.87	2.94	1.55	3.04	1.13
4.90	2.50	4.90	1.88	5.13	1.57
6.98	3.17	7.44	2.20	7.04	1.81
9.80	3.93	10.19	2.27	9.95	2.23
14.90	5.03	14.94	2.23	14.82	2.88
19.82	6.02	19.70	2.05	19.16	3.22
24.88	6.86	25.28	1.88	24.55	3.70

The solid phase in each case was unchanged cryolite.

SOLUBILITY OF $4\text{AlF}_3 \cdot 11\text{NaF}$ IN SALT SOLUTIONS AT 25°
(Lel'chuk and Ruts kaya, 1949)

gms. $4\text{AlF}_3 \cdot 11\text{NaF}$ per 1000 gms. sat. sol.

Molarity of added salt in solvent	added salt			
	Sodium Citrate $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$	Sodium Salicylate $\text{NaC}_7\text{H}_7\text{O}_3$	Sodium Oxalate $\text{Na}_2\text{C}_2\text{O}_4$	Sodium Succinate $\text{Na}_2\text{C}_4\text{H}_4\text{O}_4$
0.0	0.469	0.469	0.469	0.469
0.001	...	...	0.481	...
0.01	0.570	0.597	0.660	0.282
0.03	0.794	...	...	...
0.1	...	0.528	0.946	0.147
0.3	0.630	...	...	...
1.0	0.200	1.181	...	...

F

THE SYSTEM ALUMINUM FLUORIDE-LITHIUM FLUORIDE-WATER AT 25°
(Talipov and Antipov, 1952)

gms. per 100 gms. sat. sol.

AlF_3	LiF	Solid Phase
0.3643	0.0	$\text{AlF}_3 \cdot 3\text{H}_2\text{O}$
0.265	0.116	$2\text{AlF}_3 \cdot 5\text{LiF}$
0.1737	0.08017	"
0.03352	0.05729	$2\text{AlF}_3 \cdot 5\text{LiF} + \text{LiF}$
0.0	0.1234	LiF

SOLUBILITY OF ALUMINUM FLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

t°	gms. AlF_3 per 100 gms. HF
-24.2	Approx. 0.004
- 5.1	" 0.003
+11.2	" 0.002

SOLUBILITY OF ALUMINUM FLUORIDE IN BROMINE TRIFLUORIDE
(Sheft, Hyman, and Katz, 1953)

t°	gms. Al per 100 g. sat. sol.
25°	0.0195
70°	0.0038

ALUMINUM Hexa Antipyrine BoroFLUORIDE $[\text{Al}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_3$
(FLUOBORATE)

BF

100 gms. sat. aqueous solution contain 1.3 gm. $\text{Al}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6 \cdot (\text{BF}_4)_3$ at 20° . (Wilke-Dorfurt and Mureck, 1929.)

A1 ALUMINUM

Melting point data have been determined for the following

$\text{AlF}_3 + \text{CaF}_2$	(Fedotieff and Iljinski, 1923)
" + $\text{CaF}_2 + \text{NaF}$	(" ")
" + CsF	(Dergunov, 1948; Pushin and Baskov, 1913)
" + KF	(" ; " ; Fedotieff and Timofieff, 1932)
" + LiF	(Dergunov, 1948; Fedotieff and Timofieff, 1932)
" + NaF	(" ; Pushin and Baskov, 1913; Fedotieff and Iljinski, 1923)
$\text{AlNa}_3\text{F}_6 + \text{AlK}_3\text{F}_6$	(Naray - Szabo and Sigmond, 1941)
$\text{AlNa}_3\text{F}_6 + \text{NaF} + \text{Al}_2\text{O}_3$	(binary and ternary systems) (Fuseya, Sugihara, Nagao, and Tersoka, 1950)

F

A large number of papers on the cryoscopy of salts, oxides, etc. in molten cryolyte ($\text{AlF}_3 \cdot 3\text{NaF}$) have appeared, for example:

Added substances	Author
Many salts	Petit, 1951, 1952
Many natural silicates	Petit, 1951a
La, Th, Al, Ce, Ca, B oxides	Petit, 1952a
Mg, Ca, Zn, Cd, Ti oxides	Hayakawa and Kido, 1952
oxides and tungstates	Mergault, 1953
Na, K, Ba chlorides, TiO_2	Darmois and Rolin, 1949
$\text{Al}_2\text{O}_3 + \text{Al}$, Ca, Na fluorides	Vajna, 1953
Al_2O_3	Phillips, Singleton & Hollingshead, 1955

I ALUMINUM IODIDE AlI_3

SOLUBILITY IN BENZENE (Eley and King, 1951)

The data are the temperatures of disappearance of the last crystal of AlI_3 in a known mixture and were reproducible to 0.2° .

t°	mole % Al_2I_6	wt. % Al_2I_6	t°	mole % Al_2I_6	wt. % Al_2I_6
29.5	0.77	7.38	106.6	10.54	55.17
34.3	0.92	8.91	110.7	12.38	59.57
61.6	2.51	21.12	112.9	13.84	62.66
73.4	3.56	27.79	125.5	18.74	70.62
80.9	5.18	36.34	144.5	33.58	84.07
98.0	5.75	38.90	149.0	38.04	86.50
92.6	6.96	43.85	188.8	100.00	100.00
105.6	11.30	57.10			

SOLUBILITY IN PYRIDINE (R. Muller, 1924)

100 gms. pyridine dissolve 0.82 gms. AlI_3 at 25° .

SOLUBILITY IN LIQUID SULFUR DIOXIDE
(Jander and Ruppolt, 1937)

100 gms. liquid sulfur dioxide dissolve 0.23 gm. AlI_3 at 0° .

Melting point determinations of mixtures of AlI_3 and each of the following compounds: KI , HgI_2 , SbI_3 , AsI_3 and I_2 are given by Nijnik, 1937.

ALUMINUM IODOMERCURATE $Al(OH)I_2 \cdot 2HgI_2 \cdot 6H_2O$

I

At 15° the salt is 90.49% soluble. The hydrate melts at 48° .
(Slavko, 1953.)

ALUMINUM NITRATE $Al(NO_3)_3$

NO

SOLUBILITY IN WATER

The data of the various authors do not agree, and seem to indicate that at least two forms of $Al(NO_3)_3 \cdot 9H_2O$ probably exist. The system needs reexamination. Malquori's 1927c data are linear and are generally the highest at each temperature.

- A Malquori, 1927c
 - B Malquori, 1928c
 - C Malquori, 1929a, 1927d,e
 - D Zaslavskij and Ravdine, 1939
 - E Tanaka, 1930
 - F Milligan, 1922
 - G Inamura, 1919
 - H Saslawsky and Ettinger, 1935, 1937
- also: Saslawsky, Ettinger, and Eserowa, 1935.

t°	Gms. $Al(NO_3)_3$ per 100 gms. sat. sol.	Solid Phase
-5	12.5 A	Ice
-10	19.0 A	"
-15	23.5 A	"
-20	27.0 A	"
-25	29.5 A	"
-27 (Eutec.)	30.45 A	Ice + $Al(NO_3)_3 \cdot 9H_2O$
-20	32.5 A	$Al(NO_3)_3 \cdot 9H_2O$
-10	35.0 A	"
0	37.5 A	"
	37.56 H	"
	37.81 D	"
	37.81 B	"
	36.0 F*	"
	42.23 E	"
5	32.11 E	"
10	35.75 E	"
	40.0 A	"

*at 0.45° .

(Cont.)

A1 ALUMINUM

SOLUBILITY IN WATER---Cont.

t°	gms. Al(NO ₃) ₃ per 100 gms. sat. sol.	Solid Phase
20	42.5 A	Al(NO ₃) ₃ ·9H ₂ O
	40.0 F	"
	38.56 H	"
	38.56 D	"
25	43.5 A	"
	39.0 G	"
	39.25 C	"
30	45.0 A	"
NO	42.64 E	"
40	47.0 A	"
	46.25 B	"
	46.25 C	"
	42.65 H	"
	44.0 F	"
	45.25 D	"
50	49.0 A	"
60	51.5 A	"
	47.5 F	"
	50.95 B	"
	50.95 H	"
65	49.82 E	"
70	54.0 A	"
80	57.0 A	" + Al(NO ₃) ₃ ·8H ₂ O
90 tr. pt.	60.5 A	" + Al(NO ₃) ₃ ·8H ₂ O
95	60.7 A	Al(NO ₃) ₃ ·8H ₂ O
100	61.5 A	"
105	62.0 A	"
107 tr. pt.	62.5 A	" + Al(NO ₃) ₃ ·6H ₂ O
110	62.3 A	Al(NO ₃) ₃ ·6H ₂ O
115	62.3 A	"
120	62.5 A	"
125	63.2 A	"
129	63.8 A	"

SOLUBILITY OF ALUMINUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID (Milligan, 1922; Inamura, 1913; Malquori, 1928c; Saslowsky, Ettinger and Eserowa, 1935)

As is noted above, the agreement on the solubility in pure water is poor. The data of Milligan and of Inamura on the effect of added HNO₃ agree well. Those of Malquori show somewhat different slopes.

Milligan stirred an excess of the crystals with the acid for a first period of 30 minutes followed by a second period of a "few minutes." The data were read from curves drawn through plots of the authors' data.

Inamura suspended an excess of Al(NO₃)₃·9H₂O in aqueous nitric acid solutions and rotated in a thermostat for one or two days. The saturated solution and undissolved solid were separated by filtration through asbestos and both analyzed. For the concentrated nitric acid solutions dehydrated aluminum nitrate was used. The results when

plotted yield a curve with two branches instead of three as interpreted by the author.

Data of Milligan (0.45°, 20°, 40°, 60°) and Inamura (25°). The figures in parentheses are the approximate densities of the saturated solutions at 20°.

Gms. HNO ₃ per 100 gms. sat. sol.	gms. Al(NO ₃) ₃ per 100 gms. sat. sol.				
	0.45°	20°	25°	40°	60°
0	36.0(1.324)	40.0(1.383)	39.0	44.0(1.430)	47.5(1.461)
10	27.0(1.314)	31.0(1.368)	30.5	36.0(1.402)	40.5(1.457)
20	19.5(1.311)	23.0(1.354)	22.6	29.0(1.386)	34.5(1.457)
30	13.5(1.315)	16.0(1.345)	15.5	21.0(1.377)	29.0(1.460)
40	6.0(1.320)	9.0(1.346)	9.0	15.0(1.370)	24.0(1.468)
50	1.5(1.336)	4.0(1.345)	3.9	9.5(1.375)	20.0(1.480)
60	0.2(1.363)	1.5(1.364)	1.6	5.5(1.392)	....
65.1	....	....	1.1	....	....
68.5	....	....	1.0	....	....
70	0.25(1.432)	0.75(1.405)	..	3.0(1.430)	....
72.5	....	....	1.2*	....	....
75.0	....	....	0.6†	....	....
80.0	....	....	0.2†	....	....
85.0	....	....	0.1†	....	....
90.0	....	....	0.35†	....	....

NO

*Solid phase Al(NO₃)₃·9H₂O + Al(NO₃)₃·8H₂O

†Solid phase Al(NO₃)₃·8H₂O

Data of Malquori, 1928c and Saslawsky, Ettinger and Eserowa, 1935 (*)

Gms. per 100 gms. sat. sol.

HNO ₃	Al(NO ₃) ₃	Solid Phase
Results at 0°		
0	37.81	Al(NO ₃) ₃ ·9H ₂ O
13.28	21.18	"
45.88	2.65	"
54.74	0.12	"
73.12	0.63	" + Al(NO ₃) ₃ ·8H ₂ O
73.83*	0.19	" + "
82.31	0.17	Al(NO ₃) ₃ ·6H ₂ O + Al(NO ₃) ₃ ·8H ₂ O
82.61*	0.17	+ +
Results at 20°		
81.05*	0.30	Al(NO ₃) ₃ ·6H ₂ O + Al(NO ₃) ₃ ·8H ₂ O
72.75*	0.80	Al(NO ₃) ₃ ·9H ₂ O + "

(Cont.)

Al ALUMINUM

Gms. per 100 gms. sat. sol.

HNO_3 $\text{Al}(\text{NO}_3)_3$

Solid Phase

Results at 40°

0.0	46.25	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
16.41	28.63	"
33.41	14.52	"
60.27	2.35	" + $\text{Al}(\text{NO}_3)_3 \cdot 8\text{H}_2\text{O}$
80.25	0.45	$\text{Al}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ + $\text{Al}(\text{NO}_3)_3 \cdot 8\text{H}_2\text{O}$

Results at 60°

NO	0.0	50.95	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
	9.76	37.58	"
	27.45	25.64	"
	51.22	14.95	"
	66.12	5.95	" + $\text{Al}(\text{NO}_3)_3 \cdot 8\text{H}_2\text{O}$
	78.62	1.18	$\text{Al}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ + $\text{Al}(\text{NO}_3)_3 \cdot 8\text{H}_2\text{O}$

THE SYSTEM ALUMINUM NITRATE-POTASSIUM NITRATE-WATER AT 25° (Malquori, 1927(d))

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
KNO_3	$\text{Al}(\text{NO}_3)_3$		KNO_3	$\text{Al}(\text{NO}_3)_3$	
0.0	39.25	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	20.73	25.19	KNO_3
4.83	37.93	"	22.12	20.05	"
9.41	36.15	"	25.91	11.43	"
13.94	35.23	" + KNO_3	26.89	8.75	"
18.97	29.81	KNO_3	27.31	0.0	"

The following results for solutions saturated with both $\text{Al}(\text{NO}_3)_3$ and KNO_3 at various temperatures. (Not in very good agreement with those above.)

(Saslawsky and Ettinger, 1933)

t°	d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		KNO_3	$\text{Al}(\text{NO}_3)_3$	
0	1.406	6.47	36.0	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ + KNO_3
20	1.412	9.80	34.8	" + "
40	...	14.21	36.5	" + "
60	...	19.53	38.5	" + "

THE SYSTEM $\text{Al}(\text{NO}_3)_3 - \text{HNO}_3 - \text{KNO}_3 - \text{H}_2\text{O}$
(Malquori, 1928c)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
Al(NO ₃) ₃	KNO ₃	HNO ₃		Al(NO ₃) ₃	KNO ₃	HNO ₃	

Results at 0°				Results at 25°			
34.02	5.25	0.0	A + B	35.23	13.94	0.0	A + B
17.33	6.41	20.31	A + B	32.13	12.75	9.70	A + B
12.98	7.97	25.61	A + B	24.38	14.01	20.12	A + B
8.85	8.12	35.82	A + B	8.70	20.03	41.31	A + B
0.63	0.0	73.12	B + C	1.25	0.0	72.06	B + C
0.58	39.3	46.90	A + B + C	0.92	40.82	46.10	A + B + C
0.0	41.59	51.84	A + D	0.24	0.0	80.58	C + E
0.25	41.32	51.38	A + C + D	0.32	42.65	47.29	A + C + E
0.17	0.0	82.31	C + E				
0.22	39.12	53.10	C + D + E				

Results at 40°				Results at 60°			
				50.75	7.22	0.0	A + B
				39.91	14.17	10.39	A + B
41.71	8.51	0.0	A + B	36.69	16.18	12.34	A + B
33.44	12.55	8.43	A + B	31.28	18.58	14.92	A + B
21.19	17.31	35.80	A + B	5.95	0.0	66.12	B + C
2.35	0.0	70.27	B + C	6.10	37.47	40.70	A + B + C
2.12	39.38	44.61	A + B + C	1.18	0.0	78.62	C + E
0.45	0.0	80.25	C + E	1.15	41.13	46.51	A + C + E
0.38	42.08	47.54	A + C + E				

A = KNO ₃	D = KNO ₃ ·2HNO ₃
B = Al(NO ₃) ₃ ·9H ₂ O	E = Al(NO ₃) ₃ ·6H ₂ O
C = Al(NO ₃) ₃ ·8H ₂ O	

THE SYSTEM ALUMINUM NITRATE-SODIUM NITRATE-WATER
(Saslowsky, Ettinger and Eserowa, 1935;
Saslowsky and Ettinger, 1935, 1937).

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	NaNO_3	$\text{Al}(\text{NO}_3)_3$			NaNO_3	$\text{Al}(\text{NO}_3)_3$	
0	0.0	37.56	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	20	11.66	32.29	NaNO_3
"	3.61	33.11	"	"	22.22	19.15	"
"	9.26	31.51	" + NaNO_3	"	29.34	12.47	"
"	9.97	28.23	NaNO_3	"	29.65	12.19	"
"	13.47	22.91	"	"	46.27	0.0	"
"	18.06	16.16	"	40	0.0	42.65	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
"	27.44	9.67	"	"	10.38	38.71	" + NaNO_3
"	42.77	0.0	"	"	51.20	0.0	NaNO_3
20	0.0	38.56	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	60	0.0	50.95	$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
"	5.35	37.30	"	"	9.65	44.38	" + NaNO_3
"	10.31	35.68	" + NaNO_3	"	55.50	0.0	NaNO_3

AI ALUMINUM

Data for the system $\text{Al}(\text{NO}_3)_3 + \text{KNO}_3 + \text{NaNO}_3 + \text{H}_2\text{O}$ at 0° , 20° , 40° and 60° are given by Saslawski and Ettinger, 1935.

Data for the System $\text{Al}(\text{NO}_3)_3 + \text{HNO}_3 + \text{NaNO}_3 + \text{H}_2\text{O}$ at 0° and at 20° are given by Saslowsky, Ettinger and Eserowa, 1937.

THE SYSTEM ALUMINUM NITRATE-FERRIC NITRATE-WATER (Zaslavskij and Ravdine, 1939)

NO The authors found a continuous solid solution to exist between the hydrates at 0° , 20° , and 40° . In order to insure equilibrium, the salts were dissolved at higher temperatures, and vigorous shaking was used. Solids were analyzed by the wet residue method, and the densities, indices, and melting points of the mixed crystals were determined. This differs from the older work of Malquori (below) who found the system to have only the pure hydrated salts as saturating phases at 0° , 25° , and 40° .

Solution Wt. %			Wet Residue Wt. %		Solid Sol'n. Wt. %		Solid Phase
Al(NO ₃) ₃ , Fe(NO ₃) ₃			Al(NO ₃) ₃ , Fe(NO ₃) ₃		Al(NO ₃) ₃ , Fe(NO ₃) ₃		
Results at 0°							
37.81	0.0	...	56.6	0.0	56.6	0.0	Al(NO ₃) ₃ ·9H ₂ O
32.27	4.71	1.362	49.01	5.59	51.40	5.80	Solid Solution
26.65	9.55	...	42.50	12.88	42.70	13.0	"
23.46	12.87	1.375	39.90	16.01	40.40	16.0	"
21.10	15.57	1.378	34.62	19.89	36.0	20.3	"
17.84	20.42	...	29.78	25.71	30.6	26.1	"
15.24	23.02	...	26.77	28.26	28.1	28.9	"
11.60	26.66	1.397	22.65	33.04	23.8	33.6	"
7.94	30.64	1.405	20.72	36.42	21.0	36.6	"
4.40	34.08	1.412	10.50	45.70	11.40	47.2	"
0.0	40.15	...	0.0	59.90	0.0	59.9	Fe(NO ₃) ₃ ·9H ₂ O
Results at 20°							
38.56	0.0		56.6	0.0	56.0	0.0	Al(NO ₃) ₃ ·9H ₂ O
33.75	6.26		50.40	6.60	50.4	6.60	Solid Solution
24.36	15.97		39.76	16.88	40.6	16.70	"
18.43	23.00		31.60	24.75	33.0	24.88	"
12.92	28.57		24.37	31.84	25.8	30.30	"
11.72	10.34		25.16	32.97	25.10	33.0	"
10.56	31.85		20.17	35.53	22.20	36.2	"
6.35	37.36		13.71	43.66	14.4	44.4	"
2.4	40.80		7.99	49.78	5.50	50.6	"
1.05	42.60		3.79	53.47	4.2	55.2	"
0.0	45.20		0.0	59.9	0.0	59.9	Fe(NO ₃) ₃ ·9H ₂ O

(Cont.)

Solution Wt. %		Wet Residue Wt. %		Solid Sol'n. Wt. %		Solid Phase
Al(NO ₃) ₃	Fe(NO ₃) ₃	Al(NO ₃) ₃	Fe(NO ₃) ₃	Al(NO ₃) ₃	Fe(NO ₃) ₃	
Results at 40°						
45.25	0.0	56.6	0.0	56.6	0.0	Al(NO ₃) ₃ ·9H ₂ O
37.4	8.05	49.86	5.42	51.9	5.00	Solid Solution
32.74	12.84	48.31	7.77	49.6	7.40	"
22.13	23.51	38.40	16.89	42.0	15.5	"
17.55	29.28	32.95	24.81	33.2	24.7	"
15.04	31.20	28.43	28.15	30.4	27.65	"
10.63	37.01	24.81	31.82	27.4	30.90	"
10.1	38.60	23.59	33.96	24.6	33.7	" NO
9.13	39.85	22.23	36.33	22.23	36.3	"
8.31	41.00	19.34	38.80	20.00	38.6	"
5.32	45.19	10.62	47.69	6.2	48.0	"
1.42	49.08	6.30	53.25	6.3	53.2	"
0.0	51.18	0.0	59.9	0.0	59.9	Fe(NO ₃) ₃ ·9H ₂ O

Results of Malquori, 1927e, 1929a

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	Fe(NO ₃) ₃	Al(NO ₃) ₃	
0			
0	0.0	37.81	Al(NO ₃) ₃ ·9H ₂ O
"	7.31	30.25	"
"	17.57	17.22	"
"	23.66	12.33	"
"	25.09	11.02	" + Fe(NO ₃) ₃ ·9H ₂ O
"	34.25	2.10	Fe(NO ₃) ₃ ·9H ₂ O
"	40.15	0.0	"
25	0.0	39.25	Al(NO ₃) ₃ ·9H ₂ O
"	8.77	24.28	"
"	10.03	22.85	"
"	17.39	19.95	"
"	23.87	16.09	"
"	29.28	15.21	" + Fe(NO ₃) ₃ ·9H ₂ O
"	30.09	12.15	Fe(NO ₃) ₃ ·9H ₂ O
"	36.01	7.12	"
"	42.13	2.97	"
"	44.09	1.15	"
"	46.57	0.0	"
40	0.0	46.25	Al(NO ₃) ₃ ·9H ₂ O
"	5.22	39.83	"
"	15.13	31.22	"
"	23.06	23.30	"
"	32.69	17.12	" + Fe(NO ₃) ₃ ·9H ₂ O
"	37.66	12.16	Fe(NO ₃) ₃ ·9H ₂ O
"	39.79	8.39	"
"	51.18	0.0	"

Data for the system Al(NO₃)₃ + Fe(NO₃)₃ + KNO₃ + H₂O at 25° are given by Malquori, 1927(b).

AI ALUMINUM

Data for solutions of aluminum nitrate plus $\text{H}_2\text{C}_2\text{O}_4$, NaHC_2O_4 , and $\text{Na}_2\text{C}_2\text{O}_4$ obtained by E.M.F. measurements, conductance, spectroscopy and thermometry are given by Savchenko, 1954.

THE SYSTEM ALUMINUM NITRATE-WATER-n-HEXANOL AT 25° (Templeton, 1950)

pH (aqueous phase)	Aqueous Phase Wt. %			Alcoholic Phase Wt. %			Solid Phase	
	Al(NO ₃) ₃	H ₂ O	C ₆ H ₁₃ OH	Al(NO ₃) ₃	H ₂ O	C ₆ H ₁₃ OH		
..	41.2	58.2	0.6	7.92	9.65	82.4	Al(NO ₃) ₃ · 9H ₂ O	
0.60	41.2	59.2	(-0.4)	7.83	9.55	82.6		
NO	0.72	39.9	60.3	(-0.2)	6.89	9.21	83.9	Two Liquid Phases
0.66	38.3	61.2	0.5	5.84	8.53	85.6		
..	38.1	60.2	1.7	5.98	8.71	85.3		
0.92	35.6	63.5	0.9	4.27	7.74	88.0		
0.90	35.0	64.7	0.2	3.62	7.07	89.3		
1.20	31.5	67.9	0.6	1.99	5.77	92.3		
..	31.3	69.7	(-1.0)	1.81	5.81	92.4		
..	30.5	67.9	1.6	1.78	5.66	92.6		
..	26.0	73.5	0.5	0.72	5.12	94.2		
1.74	23.0	76.3	0.7	0.24	5.03	94.7		
2.09	20.3	78.8	0.9	0.10	5.14	94.8		
2.20	17.14	81.6	1.2	0.041	5.47	94.5		
2.40	13.84	84.8	1.3	0.032	5.83	94.1		
..	11.9	86.8	1.3	...	6.05	93.9		
2.64	9.41	90.3	0.3	0.0106	6.22	93.7		
2.78	6.27	92.5	1.2	0.0032	6.52	93.4		
..	0.00	99.4	0.62	0.00	7.11	92.9		

SOLUBILITY OF $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ IN n-HEXANOL AT 25° (Templeton, 1950)

A solution saturated with $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ contains 7.10% $\text{Al}(\text{NO}_3)_3$.

O ALUMINUM OXIDE Al_2O_3

OH ALUMINUM HYDROXIDE $\text{Al}(\text{OH})_3$

SOLUBILITY IN WATER

The value 1×10^{-5} moles Al_2O_3 per liter was found by conductivity and electrometric titration by Remy and Kuhlman (1924), Remy (1925) at 18°, and by Busch (1927) at 29°. More recent determinations are:

t°	Ksp	Authors	Methods
20	1.25×10^{-33}	Szabo, Csanyi, and Kaval, 1955	(Potentiometric titration, Nephelometry)
22	4.8×10^{-31}	Kovalenko and Nestorovich, 1955	(Polarography in KNO solution)
25	1.2×10^{-30}	Korenman, Frum, and Kudinova, 1953	(Determination of the pH of precipitation)
"Room"	5.5×10^{-30}	Oka, 1940	(Potentiometric titration)
30	1.92×10^{-32}	Szabo, Csanyi, and Kaval, 1955	(Potentiometric titration, Nephelometry)

0

Assuming $[\text{OH}^-] = 10^{-7}$ in the expression $K_{sp} = [\text{Al}^{+++}][\text{OH}^-]^3$, the solubility as calculated from these values is 10^{-9} to 10^{-12} moles $\text{Al}(\text{OH})_3$ per liter.

On the basis of experiments which determined the stable solid phase at various temperatures, Laubengayer and Weisz, 1943 present a schematic diagram for the system $\text{Al}_2\text{O}_3\text{-H}_2\text{O}$. The system was studied from 100° to 500° up to 50,000 lbs./in² by Ervin and Osborn, 1951. The regions of stability of the various phases are approximately as follows:

Gibbsite (monoclinic $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) all pressures, below 135°
 Boehmite (orthorhombic $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (+)) all pressures, $135^\circ\text{-}280^\circ$;
 up to 2000 lbs./in², $280^\circ\text{-}380^\circ$
 Diaspore (orthorhombic $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (-)) above 2000 lbs./in², $280^\circ\text{-}420^\circ$
 Corundum (hexagonal Al_2O_3) all pressures above $380^\circ\text{-}420^\circ$

Terem, 1950 has studied the hydrates of Al_2O_3 by means of heating curves.

SOLUBILITY OF Al_2O_3 IN ACIDS

See also pp. 200-2, 5-8

$\gamma\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ was prepared by Huttig and Markus (1939) and heated to various temperatures for varying periods of time. The solubilities of these preparations in HCl were determined by varying the following factors: amount of starting material, amount of solvent, concentration of solvent, amount, temperature and time of contact.

The $\gamma\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ was also prepared in contact with a number of different gases. The effect of each gas on the $\gamma\text{Al}_2\text{O}_3 \rightarrow \alpha\text{Al}_2\text{O}_3$ transition was determined by the solubility of the product resulting from each treatment.

SOLUBILITY OF ALUMINUM OXIDE IN BOILING SULFURIC ACID SOLUTION (Rylands and Jenkinson, 1943)

One gram of pure Al_2O_3 was placed in contact with 100 cc of boiling sulfuric acid solution for 20 minutes. The amount of Al_2O_3 remaining was then determined. The results are read from a curve plotted by the authors.

A1 ALUMINUM

Gms. H ₂ SO ₄ per 100 gms. solvent	Boiling Point	Gms. Al ₂ O ₃ Dissolved	Gms. H ₂ SO ₄ per 100 gms. solvent	Boiling Point	Gms. Al ₂ O ₃ Dissolved
20	104°	0.04	80	205°	0.54
30	108°	.05	85	232°	.65
40	113°	.07	90	261°	.65
50	124°	.10	95	291°	.58
60	142°	.14	100	338°	...
70	168°	.19			

SOLUBILITY OF ALUMINUM OXIDE - ACID ADDITION COMPOUNDS AT 25° (Shisbniashvili, Kargin, and Batsanadze, 1947)

O
OH

Determined by conductivity measurements:

(Al ₂ O ₃ H) ₂ SO ₄	8.6 x 10 ⁻⁵ gm. equiv. per liter
(Al ₂ O ₃ H) ₂ PO ₄	7.66 x 10 ⁻⁵ "
(Al ₂ O ₃ H) ₂ HPO ₄	6.08 x 10 ⁻⁵ "
(Al ₂ O ₃ H) ₂ SiO ₃	4.9 x 10 ⁻⁵ "
(Al ₂ O ₃ H)Cl	180 gms. per 100 gms. H ₂ O

The system Al₂O₃ - SO₂ - H₂O (Fischer and Burger, 1943) was studied by the evaporation of solutions of Al₂O₃ and SO₂ at room temperature in an atmosphere of SO₂. Two compounds Al₂O₃·2SO₂·xH₂O and Al₂O₃·3SO₂·yH₂O were found.

Monzhalei, 1942 found the minimum solubility of Al(OH)₃ in water to lie between pH 5.9 - 7.7, with or without KCl in the solution. Aged Al(OH)₃ was less soluble.

SOLUBILITY OF Al₂O₃ IN ALKALIS

SOLUBILITY OF ALUMINUM HYDROXIDE IN AQUEOUS SOLUTIONS OF POTASSIUM HYDROXIDE (Fricke and Jucatis, 1930)

Weighed amounts of specially prepared aluminum hydroxide and measured volumes of potassium hydroxide solution of known concentration were shaken together in Jena flasks at constant temperature for periods up to six weeks. The clear supernatant solutions obtained by sedimentation or filtration through hardened filters were analyzed. The dissolved aluminum hydroxide was precipitated by diluting and passing in carbon dioxide, and then weighed. The alkali was titrated. The composition of the solid phase was determined by direct analysis and by the "rest" method of Schreinemakers. The solid phases were also examined microscopically and rontgenographically.

Results at 30°

Mixtures shaken 3 weeks

Gms. per 100
gms. sat. sol.

K ₂ O	Al ₂ O ₃	Solid Phase
7.77	0.95	Al ₂ (OH) ₆
21.00	2.62	"
28.80	12.71	"
29.10	16.70	"
29.63	16.60	K Aluminate
37.21	4.08	"

Results at 60°

Mixtures shaken one week

Gms. per 100
gms. sat. sol.

K ₂ O	Al ₂ O ₃	Solid Phase
7.92	1.90	Al ₂ (OH) ₆
21.60	10.24	"
25.64	15.92	"
27.81	19.42	"
28.27	21.55	"
38.33	7.08	K Aluminate 0 OH

SOLUBILITY OF ALUMINUM HYDROXIDE IN AQUEOUS SOLUTIONS OF
SODIUM HYDROXIDE

— (Fricke and Juctigis, 1930)

The same procedure was employed as described above for the solubility of aluminum hydroxide in aqueous solutions of potassium hydroxide. The authors discuss the results of Gondriaan, 1922 (see under Sodium Aluminates), and point out that his values for preparation B are in fair agreement with the present results, but the much lower figures obtained for preparations x and y, as well as the two maximum points in his solubility curve, could not be confirmed. The earlier data of Slade, 1911, 1912 and Haber and van Oordt, 1904 (stirred for 24 hrs) are not in good agreement with these.

The experiments of Herz, 1911 and Slade, 1911 and 1912 show that the ratio of Na to Al in the solution varies considerably depending upon whether the used Al hydroxide was precipitated hot or cold, also upon the length of time it was dried and upon the nature of the drying agent. Herz found a nearly constant ratio of 3Na to 1Al in solution. Slade gives ratios of approximately 2.5:1 in normal NaOH at 25° for cold precipitated hydroxide dried over H₂SO₄ and 9.0:1 for hot precipitated Al hydroxide dried over P₂O₅. Drying in thin layers also increased this ratio but to a somewhat less extent.

Ponomarev and Ruben, 1953 found the solubility in NaOH and Na₂S solutions depends greatly on the surface area of the precipitate.

Al ALUMINUM

Data of Fricke and Justigis, 1930.

Results at 30°			Results at 60°		
Mixtures shaken 6 weeks			Mixtures shaken 3 weeks		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Na ₂ O	Al ₂ O ₃		Na ₂ O	Al ₂ O ₃	
3.95	0.70	Al ₂ (OH) ₆	3.87	1.41	Al ₂ (OH) ₆
9.68	1.82	"	16.62	11.00	"
15.23	4.31	"	19.94	24.45	" + Na ₂ O·Al ₂ O ₃ ·H ₂ O
17.98	6.63	"	21.21	23.34	Na ₂ O·Al ₂ O ₃ ·H ₂ O
21.10	15.99	"	22.35	13.79	"
21.95	25.59	"	37.23	1.46	"
24.78	6.45	Na ₂ O·Al ₂ O ₃ ·H ₂ O	39.86	1.53	"
26.53	3.50	"	43.91	0.78	"
30.95	1.93	"			
35.90	1.16	"			
38.50	0.44	"			

Data of Slade, 1910, 1911 and Haber and van Oordt, 1904 (20-23°)

Normality of NaOH:	0.49	0.6414(S.)	0.99	2.00
gms. Al ₂ O ₃ per liter:	9.27	13.4(S.)	13.90	14.40

See also Vol'f and Kuznetsov, 1955 for data at various temperatures in 5-20% Na₂O solutions.

SOLUBILITY OF ALUMINUM HYDROXIDE IN AQUEOUS SOLUTIONS OF AMMONIUM HYDROXIDE AT 20° (Archibald and Habasian, 1917)

The freshly prepared Al(OH)₃ suspended in aqueous NH₄OH solutions was rotated in sealed tubes at constant temperature until attainment of equilibrium. The solutions were filtered and 10 cc. portions evaporated and residues weighed in platinum crucibles.

Normality of NH ₄ OH solution	Gms. Al(OH) ₃ dissolved per 100 cc. sat. sol.	Normality of NH ₄ OH solution	Gms. Al(OH) ₃ dissolved per 100 cc. sat. sol.
0.05	0.0070	0.200	0.038
0.10	0.0080	0.500	0.045
0.125	0.025	1.000	0.024

SOLUBILITY OF ALUMINUM HYDROXIDE IN AQUEOUS SOLUTIONS OF AMMONIUM
HYDROXIDE CONTAINING AMMONIUM NITRATE AND POTASSIUM NITRATE
(Archibald and Habasian, 1917)

t°	Normality of NH ₄ OH	Wt.% added NH ₄ NO ₃	Gms. Al(OH) ₃ per 100 cc sat. sol.	t°	Normality of NH ₄ OH	Wt.% added KNO ₃	Gms. Al(OH) ₃ per 100 cc sat. sol.
20	1.0	5.0	0.0190	20	1.0	5.0	0.0760
20	1.0	10.0	0.0085	20	1.0	10.0	0.1310
20	1.0	30.0	0.0036	30	1.0	5.0	0.1120
20	0.5	5.0	0.0145	30	1.0	10.0	0.1320
20	0.5	10.0	0.0011	20	0.5	5.0	0.0450
30	1.0	5.0	0.0143	20	0.5	10.0	0.0485
30	1.0	10.0	0.0066	30	0.5	5.0	0.0713
30	0.5	5.0	0.0081	20	0.5	10.0	0.0133
30	0.5	10.0	0.0010				

OH

SOLUBILITY OF ALUMINUM HYDROXIDE IN ALUMINUM SULFATE SOLUTIONS
(Gromov, 1948 (18°); Kremann and Huttinger, 1908 (20°, 40°, 60°))
See also p. 209-11

Gromov's data have been recalculated for comparison with the older work. The solubility is about one-tenth that found by Kremann and Huttinger (error of decimal point?). The composition of the solid phase also differs.

density	pH	gms. per 100 gms. H ₂ O		Solid Phase
		Al ₂ (SO ₄) ₃	Al(OH) ₃	
		Results at 18° (G.)		
1.000	4.43	0.0	~ 0	Al ₂ O ₃ · H ₂ O
1.002	4.20	0.18	~ 0	2Al ₂ O ₃ · SO ₃ · H ₂ O
1.005	4.11	0.34	0.0043	"
1.011	3.98	0.91	0.014	"
1.032	3.84	3.4	0.026	"
1.052	3.71	8.8	0.06	"
1.089	3.65	12.6	0.13	"
1.148	3.45	21.9	0.17	"
1.266	3.26	34.9	0.29	" + Al ₂ (SO ₄) ₃ · 18H ₂ O

Results at 20° (K. & H.)

...	...	2.37	0.15	Al ₂ O ₃ · SO ₃ · 9H ₂ O
...	...	5	0.30	"
...	...	7	0.65	"
...	...	9.1	1.30	" + Al ₂ O ₃ · 2SO ₃ · 12H ₂ O
...	...	10	1.23	Al ₂ O ₃ · 2SO ₃ · 12H ₂ O
...	...	15	1.04	"
...	...	20	1.40	"
...	...	25	2.40	"
...	...	30	3.70	"
...	...	31.6	4.20	" + Al ₂ (SO ₄) ₂ · 16H ₂ O
...	...	33	2.75	"
...	...	34.73	0.92	"

(Cont.)

AI ALUMINUM

density	pH	Gms. per 100 gms. H ₂ O		Solid Phase
		Al ₂ (SO ₄) ₃	Al(OH) ₃	
Results at 40° (K.&H.)				
...	...	5.22	1.33	Al ₂ O ₃ ·SO ₃ ·9H ₂ O
...	...	8.85	1.82	Al ₂ O ₃ ·2SO ₃ ·12H ₂ O
...	...	10	1.65	"
...	...	15	1.40	"
...	...	20	2.15	"
...	...	25	3.80	"
...	...	28.5	5.80	" + Al ₂ (SO ₄) ₃ ·16H ₂ O
...	...	30	4.35	Al ₂ (SO ₄) ₃ ·16H ₂ O
...	...	35	1.60	"
...	...	49	0.60	"
Results at 60° (K.&H.)				
...	...	3.24	0.75	Al ₂ O ₃ ·SO ₃ ·9H ₂ O
...	...	8.83	2.53	Al ₂ O ₃ ·2SO ₃ ·12H ₂ O
...	...	12.67	1.85	"
...	...	24.07	3.14	"
...	...	31.55	4.89	"
...	...	42.38	6.02	Al ₂ (SO ₄) ₃ ·16H ₂ O
...	...	49.85	1.42	"

The solubility of alumina in Ringer's solution (10g NaHCO₃ + 0.42g KCl + 0.48g CaCl₂ + 2.0g dextrose in 1 liter adjusted to pH 7.4 with HCl) and in H₂O is not much affected by the presence of silica at room temperature and at 37°. (Jephcott and Johnson, 1950.)

The phase diagrams of the systems Al₂O₃ - Ga₂O₃ and Al₂O₃·H₂O - Ga₂O₃·H₂O are given by Hill, Roy, and Osborn, 1942. Extensive solid solutions are formed.

PO ALUMINUM PHOSPHATES xAl₂O₃·yP₂O₅·zH₂O

THE SYSTEM Al₂O₃ - P₂O₅ - H₂O
(Jameson and Salmon, 1954 (25°);
Brosheer, Lenfesty, and Anderson, 1954 (25°, 50°, 75°);
Guerin and Martin, 1952 (60°); Brutskus, 1955 (80°))

There is general agreement as to the compositions of the saturated solutions, but the compositions of at least two of the solid phases are in doubt. Hydrated AlPO₄ (Al₂O₃·P₂O₅·αH₂O) was found by all investigators, but the value of α is uncertain, and seems to lie between 4 and 7 [AlPO₄·2H₂O — AlPO₄·3.5H₂O]. At 80° the careful work of Brutskus showed it to be $\frac{4}{3}$ (AlPO₄·2H₂O), but at lower temperatures the data are inconclusive. As the P₂O₅ content of the solution is increased, J. & S. at 25°, and G. & M. at 60°, report the compound 2Al₂O₃·3P₂O₅·10H₂O [4AlPO₄·2H₃PO₄·7H₂O]. Brutskus found 2Al₂O₃·3P₂O₅·nH₂O (n = 15-17) at 80°, but studied it only in a metastable region (up to 15% P₂O₅ in solution). B. L. and A. do not report a 2:3 salt at any temperature. At similar P₂O₅ concentrations their tie-lines indicate roughly Al₂O₃·2P₂O₅·9H₂O

[$\text{AlPO}_4 \cdot \text{H}_3\text{PO}_4 \cdot 3\text{H}_2\text{O}$]. This solid differs considerably in composition from the former, but the authors present reasonably good evidence for its existence. Probably one of the phases is metastable. Guerin also found $\text{Al}_2\text{O}_3 \cdot 2\text{P}_2\text{O}_5 \cdot 4\text{H}_2\text{O}$ at 60° . All authors agree that $\text{Al}_2\text{O}_3 \cdot 3\text{P}_2\text{O}_5 \cdot 6\text{H}_2\text{O}$ [$\text{AlPO}_4 \cdot 2\text{H}_3\text{PO}_4$] saturates the most acidic solutions.

It should be noted that equilibrium required many months to attain and that the solids settled slowly. The convergence of the tie lines was not always good. J. and S. apparently relied on the data of G. and M. when drawing their conclusions.

Compositions of solid phases are given in ratios $\text{Al}_2\text{O}_3 : \text{P}_2\text{O}_5 : \text{H}_2\text{O}$

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Al ₂ O ₃	P ₂ O ₅		Al ₂ O ₃	P ₂ O ₅	
Results at 25° (B.L. & N.)					
0.04	1.06	1:1:4-6	6.03	32.56	1:1:4-6
0.46	5.09	"	7.65	35.51	M
1.06	8.46	"	8.58	36.48	"
1.07	8.68	"	7.93	36.48	"
2.01	11.90	"	6.57	35.75	1:2:9
2.19	12.37	"	8.51	38.32	M
2.25	14.01	"	7.44	37.00	"
2.24	14.02	"	8.84	39.07	"
3.03	16.81	"	6.41	37.17	1:2:9
4.50	22.57	"	6.49	38.47	"
4.23	23.21	"	6.45	38.85	"
4.66	23.74	"	6.29	42.79	"
5.46	26.32	"	6.28	43.09	"
6.17	28.18	1:2:9	6.14	45.84	"
6.15	29.94	"	5.93	46.78	"
7.31	33.13	M	6.03	49.44	"
7.32	34.20	"	6.73	53.15	"
7.40	34.65	"	7.25	54.57	"

Results at 25° (J. & S.)

0.0791	1.063	1:1:7	5.08	30.96	2:3:10
0.2906	3.016	"	4.84	34.88	"
0.558	4.832	"	4.85	38.45	"
1.124	8.111	"	5.06	40.03	"
1.984	11.23	"	5.60	44.16	"
2.845	14.86	"	6.17	47.67	"
3.354	15.14	"	6.78	49.00	"
3.803	16.42	"	6.89	49.96	"
4.054	17.89	1:1:4	7.15	51.86	1:3:6
4.270	20.21	"	5.75	53.77	"
4.516	23.18	"	5.57	54.34	"
5.150	27.12	"	4.64	57.21	"
5.382	28.23	"	4.30	59.13	"

M = metastable

(Cont.)

AI ALUMINUM

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Al ₂ O ₃	P ₂ O ₅		Al ₂ O ₃	P ₂ O ₅	
Results at 60° (G. & M.)					
0.0	0.0	1:1:7	8.8	52.7	{ 2:3:10 +1:2:4 1:2:4 +1:3:6 1:3:6
6.8	31.2	{ 1:1:7 +1:1:4 1:1:4 +2:3:10	8.7	54.5	
7.9	40.7		7	54.5	

PO Results at 50° (B.L. & N.)					
0.01	0.05	1:1:4-6	7.31	36.02	M
0.10	3.60	"	7.47	37.69	1:2:9
0.36	6.35	"	7.74	38.82	"
0.65	8.62	"	7.47	43.71	"
1.14	11.39	"	7.55	46.27	"
1.73	14.77	"	7.52	47.18	"
1.89	15.39	M	7.90	50.86	"
3.70	22.53		8.42	52.98	"
4.79	27.02	M	8.63	54.22	{ 1:2:9 + 1:3:6
6.02	31.44	"			1:3:6
6.84	34.65	"	6.26	55.60	1:3:6
			2.09	60.05	"

Results at 75° (B.L. & N.)					
0.05	3.77	1:1:4-6	8.13	41.77	1:1:4-6
0.17	6.35	"	9.39	44.37	1:1:4-6 +
0.54	10.36	"			1:2:9
1.24	15.21	"	9.38	46.16	1:2:9
2.65	22.76	"	9.37	49.10	"
3.16	24.86	"	8.26	50.52	1:3:6
4.14	29.02	"	7.36	53.03	"
4.58	30.72	"	6.44	55.04	"
5.65	34.67	"	6.02	56.29	"
5.95	35.01	"	4.09	58.29	"
6.35	36.15	"			

Results at 80° (B.)					
0.10	2.90	1:1:4	- metastable data -		
0.16	4.69	"			
0.20	5.51	"	0.07	1.57	2:3:15-17
0.24	7.12	"	0.98	3.80	"
0.44	10.35	"	1.09	4.05	"
0.55	11.16	"	1.13	4.10	"
1.10	15.55	"	1.40	5.12	"
1.79	19.08	"	1.44	5.47	"
2.49	22.18	"	1.46	6.12	"
2.85	24.26	"	1.61	7.19	"
5.13	30.08	"			
			1.63	7.24	2:3:15-17
			1.77	7.38	"
			1.99	9.00	"
			2.90	12.80	"
			3.62	13.90	"
			3.94	14.0	"
			4.43	14.27	"
			4.61	15.14	"

SOLUBILITY OF ALUMINUM ORTHOPHOSPHATE AlPO_4

The solubility product $[\text{Al}^{+++}][\text{PO}_4^{---}]$ at 18-20° is 1.3×10^{-20} . (Zharovskii, 1951.)

Ghani and Aleem (1943) shook 10 mg. of AlPO_4 with 0.5 N acetic acid, 0.25 N sodium hydroxide, and 2 N sulfuric acid for 2 hours at room temperature and reported the mg. of P_2O_5 found in the volume of solvent used. The figures were recalculated into more convenient form:

Solvent	Mg. P_2O_5 found	Mg. AlPO_4 per 100 ml. solution
0.5 N acetic acid	2.8 in 250 ml.	1.9
0.25 N NaOH	3.8 in 500 ml.	1.3
2.0 N H_2SO_4	4.40 in 250 ml.	3.0

The solubility of aluminum phosphate in water and in 0.2 N and 1.0 N potassium carbonate solutions, cold and at the boiling point, is given by Devyatin, 1940.

The solubility of aluminum phosphate from various soils in hydrochloric acid and ammonia solutions under varying conditions was determined by Fraps, 1911.

For further data see Gaarder, 1930.

ALUMINUM SULFIDE Al_2S_3

S

Fusion-point data for mixtures of $\text{Al}_2\text{S}_3 + \text{Ag}_2\text{S}$ are given by Cambi, (1912)

The system $\text{Al}_2\text{S}_3 - \text{Fe} - \text{FeS} - \text{Al}$ was studied by x-ray and thermal analysis by Vogel and Hillen, 1942.

ALUMINUM SULFATE $\text{Al}_2(\text{SO}_4)_3$

SO

SOLUBILITY IN WATER

The older data of Kremann and Huttinger (1908) have not been confined by recent workers. At 25° the agreement between all the various data are excellent; below 25° K. and H.'s data seem too low, above 25° they are (increasingly) too high. The results of Taylor and Bassett (1952), Horan and Skarulis (1939), Smith and Walsh (1954), Sanders and Dobbins (1931), Gee (1945) (at 30°), and Schreinemakers and De Waal (1906) lie on a smooth curve from the eutectic (-12°) to 110° (which is the melting point of $\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$ and also the approximate boiling point of the solution.) The data of Henry and King (1949) and Smith and Walsh at 80° lie on a curve paralleling that of Taylor and Bassett but about 1% higher. Hence these data support the shape of the solubility curve established by Taylor and Bassett, but probably show the presence of some systematic error. Henry and King's value at 25° (28.3%) somewhat higher than the average of eleven others ($27.78 \pm .17$) and thus may indicate that these data are a little too high. The data

A1 ALUMINUM

of Dobbins and Addleston (1935) and Dobbins and Byrd (1931) are very high. Those of Funaki (1950) sometimes agree with the original work of Kremann and Huttinger, but at 3 of the 5 temperatures studied, Funaki reports duplicate data which differ by 1%.

The degree of hydration of the solid phase has received considerable study. Older workers thought it to be $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ but this was questioned by Horan and Skarulis (1939), Hill, Smith, and Ricci (1940), Smith (1942), Taylor and Bassett (1952), Smith and Walsh (1954) and others, using a variety of phase rule, vapor pressure, and tracer techniques. The best view now seems to be that the hydration lies between 16 and 17 moles of H_2O , and is variable. It may be considered $\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$ which contains up to 1 mole of zeolitic water. This water is within the lattice and is not lost on exposure to air.

30

Further solubility references not mentioned above are: Wirth (1912), Wirth and Bakke (1914), Caren and Mitchell (1925, 1925a), Occels-shaw (1925), Britton (1922), Bassett and Watt (1950), Hill and Kaplan (1938), Ts'ai and Yen (1936), Mousseron and Gravier (1942).

SOLUBILITY OF ALUMINUM SULFATE IN WATER

t°	Gms. $\text{Al}_2(\text{SO}_4)_3$ per 100 gms. sat. sol.		Solid Phase	t°	Gms. $\text{Al}_2(\text{SO}_4)_3$ per 100 gms. sat. sol.		Solid Phase
-0.8	6.37 ^b		Ice	55	30.4 ⁱ		$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
-1.02	8.09 ^a		"		(31.2)		
-1.43	10.7 ^a		"	60	31.0 ⁱ		"
-2.04	14.3 ^a		"		(31.8)		
-3.3	16.20 ^b		"	65	31.8 ⁱ		"
-9.6	23.9 ^b		"		(32.9)		
-12.0	27.2 ^b		Ice + $\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	70	32.8 ⁱ		"
0	27.50 ^c		$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	73.4	33.33		"
10	27.6 ⁱ		"	75.0	33.63		"
25	27.82 ± 0.19 ^d		"	76.7	34.28		"
	(28.3)			80.6	...		"
30	28.0 ^e (28.6)		"		37.4 ^b		
35	28.4 ⁱ (2.89)		"	82.0	36.60		"
40	28.8 ⁱ (29.6)		"	88.0	38.74		"
45	29.4 ⁱ (30.0)		"	95.1	41.86		"
50	29.9 ^b (30.6)		"	99.2	43.90		"
				103.2	46.8 ^f		"
				110.4	52.0		"
				112.2	53.0		"

a = Kremann and Huttinger, 1908.

b = Smith and Walsh, 1954.

c = Horan and Skarulis, 1939.

d = average of 12 investigators.

e = Schreinemakers and DeWaal, 1906.

f = Taylor and Bassett, 1952.

i = interpolated from Taylor and Bassett.

() Data in parentheses are those of Henry and King, 1949.

THE SYSTEM $\text{Al}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O} - \text{"ACIDIC REGION"}$

THE SOLUBILITY OF ALUMINUM SULFATE IN SULFURIC ACID SOLUTIONS

The data of Taylor and Bassett (1952), Fanuki (1950), and Henry and King (1949) are in agreement. The diagrams of Collet (1950) also confirm the shape of the solubility curve. The older work of Wirth (1912) and Dobbins and Thomas (1937) have been found to be incorrect. There is considerable disagreement on the compositions of the solid phases. The 16-17 hydrate (see above) is still referred to as an 18 hydrate by Funaki and Collet, but these authors indicate that the composition becomes more nearly $16\text{H}_2\text{O}$ as H_2SO_4 is added to the solution. The first distinct phase change occurs when about 48% H_2SO_4 (at 25°) is present in the solution: $\text{Al}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ is apparently formed, but the tie-line evidence is not conclusive. Collet thinks it is $\cdot 10\text{H}_2\text{O}$, while Taylor and Bassett believe, on the basis of "tracer" experiments, it to be $\text{Al}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$ [which contains about the same total percentage of H_2O]. $\text{Al}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$ was similarly found to be $\text{Al}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$. Both Taylor and Bassett and Collet agree on a 1:1 compound of low hydration ($\cdot 2\text{H}_2\text{O}$ T. & B.; $\cdot 4\text{H}_2\text{O}$ C.); Funaki found $\text{Al}_2\text{SO}_4 \cdot 5\text{H}_2\text{SO}_4$. At higher temperatures the results are much more complicated and several phases exist metastably. The data and interpretation of Taylor and Bassett (30° , 50° , 60°) are considerably more complex than those of Henry and King (60°). A few data are also given by Bassett and Goodwin, 1949. Collet's (1950) transitions [read from the graph] occur as follows (at 20°):

$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O} \longrightarrow \cdot 16\text{H}_2\text{O}$ at 41% H_2SO_4 ; $\cdot 16\text{H}_2\text{O} \longrightarrow \cdot 10\text{H}_2\text{O}$ at 53% H_2SO_4 ; $\cdot 10\text{H}_2\text{O} \longrightarrow \cdot 6\text{H}_2\text{O}$ at 71.3% H_2SO_4 , 0.8% $\text{Al}_2(\text{SO}_4)_3$; $\cdot 6\text{H}_2\text{O}$ $\text{Al}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$ at 78.0% H_2SO_4 , 2.2% $\text{Al}_2(\text{SO}_4)_3$.

(Cont.)

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THE SYSTEM $\text{Al}_2(\text{SO}_4)_3 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ (Cont.)

Results at 25°

The numerical data are those of Taylor and Bassett. Those of Funaki are very similar. Solid Phase ratios are $\text{Al}_2\text{O}_3:\text{SO}_3:\text{H}_2\text{O}$.

Gms. per 100 gms. sat. sol.		Solid Phase		
$\text{Al}_2(\text{SO}_4)_3$	H_2SO_4	Taylor and Bassett (1952)	Funaki (1950)	
30				
27.76	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	
27.74	0.0			
27.79	0.0			
23.89	4.78			
16.88	14.60			
16.84	12.27	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	
5.23	36.12			
3.995	41.01			
3.19	45.26			
3.05	45.99			
3.14	47.30	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O} + 1:1:12$	$\text{Al}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	
3.13	47.53			
3.22	48.30			
2.50	49.55			
2.46	50.10			
0.95	56.21	1:1:12	$\text{Al}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	
0.75	58.10			
0.62	58.89			
0.56	63.48			
0.64	65.32			
*0.68	66.20	1:1:12	$\text{Al}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	
*1.42	68.68			
0.67	65.66			
0.23	68.36			
0.59	69.32			
0.18	73.20	1:1:8 α	$\cdot 9\text{H}_2\text{O} + 1:5:0$	
0.19	73.93			
.80	78.0			
0.57	78.13			
*0.77	79.77			
*1.08	80.25	1:1:8 α + 1:1:8 β *	1:5:0	
0.6	78.5			
**1.12	72.61			
*0.36	74.60			
*0.37	74.60			
**1.31	75.33	1:1:2		
0.18	82.49			
0.12	83.92			
0.14	86.48			
0.01	92.71			
0.07	99.30			

* = Metastable.

** = May be supersaturated.

(Cont.)

THE SYSTEM $\text{Al}_2\text{SO}_4 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ (Cont.)

Results at 30°

(Taylor and Bassett, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	SO
$\text{Al}_2(\text{SO}_4)_3$	H_2SO_4		$\text{Al}_2(\text{SO}_4)_3$	H_2SO_4		
3.98	45.24	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	3.01	49.71	1:1:12	
4.36	46.86	" + 1:1:12	0.93	57.89	1:1:12	
4.06	47.50	1:1:12				

Results at 50°

(Taylor and Bassett, 1952)

29.70	0.0	} $\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	3.29	52.41	2:1:24	
25.53	5.28		3.30	53.90	2:1:24 + 1:1:12	
20.57	13.22		*3.81	52.53	} 1:1:12	
11.67	31.27		*3.48	53.61		
10.02	36.41		3.27	54.20		
*9.91	39.65		2.27	59.03		
*9.90	40.36	} $\cdot 16\text{H}_2\text{O} + \cdot 14\text{H}_2\text{O}$	*2.22	61.31	} 1:1:12 + 1:1:8 α	
10.0	37.0		2.20	60.00		
8.93	39.40	$\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$	0.77	64.90	} 1:1:8 α	
8.2	41.5	$\cdot 14\text{H}_2\text{O} + 2:1:24$	0.43	72.70		
*9.91	38.90	$\cdot 16\text{H}_2\text{O} + 2:1:24$	0.71	76.73	} 1:1:8 α + 1:1:2	
7.52	42.08	} 2:1:24	*1.33	78.43		
7.47	42.60		0.80	77.00		
6.16	44.94		0.07	83.00		
5.61	46.26		0.07	92.50		
3.54	51.40					

* = Metastable

(Cont.)

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THE SYSTEM $\text{Al}_2(\text{SO}_4)_3 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ (Cont.)

Results at 60°

(Henry and King, 1949)		(Taylor and Bassett, 1952)		
31.83	0.0	*14.82	31.56	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
29.31	2.37	*14.43	33.91	
27.87	4.55	14.3	34.4	
26.15	7.09			$\cdot 16\text{H}_2\text{O} + 2:1:24$
23.82	11.03			$\cdot 16\text{H}_2\text{O} + \cdot 14\text{H}_2\text{O}$
21.88	14.25	17.0	25.5	$\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$
19.29	19.57	12.56	32.80	
16.44	25.93	10.18	37.45	
14.59	32.52	9.59	39.23	$\cdot 14\text{H}_2\text{O} + 2:1:24$
14.67	35.19	8.00	44.00	
10.41	39.61	*12.62	36.60	
7.67	43.95	*12.44	36.95	$2:1:24$
5.99	48.11	*11.44	38.39	
5.04	50.95	*10.31	40.11	
4.43	55.09	*9.21	42.09	$2:1:24 + 1:1:12$
4.09	56.86	6.76	46.61	
*4.25	60.82	4.7	54.5	
3.76	58.93	*6.52	49.74	$1:1:12$
0.92	65.61	*5.27	52.43	
0.63	69.94	3.96	57.53	
0.63	72.82			$1:3:12$
0.99	76.18			
1.76	78.30			
0.17	82.57			$1:3:12 + \text{Al}_2(\text{SO}_4)_3$
0.17	86.84			
0.09	90.89			
Trace	96.08			$\text{Al}_2(\text{SO}_4)_3$

* = Metastable.

** = May be supersaturated.

Results at the Boiling Point (Rylands and Jenkinson, 1943)

The values were read from a graph given by the authors.

Gms. H_2SO_4 per 100 gms. solvent	Boiling Point	Gms. $\text{Al}_2(\text{SO}_4)_3$ per 100 cc solvent
70	168°	235
75	185°	180
80	205°	120
85	232°	60
90	261°	0

THE "BASIC REGION" OF THE SYSTEM $\text{Al}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$

The system has been studied (with reasonable agreement) by Kremann and Huttinger (1908) (20°, 40°, 60°), Henry and King (1950) (60°), and in considerable detail, by Bassett and Goodwin (1949) (25°). Neither the solid nor liquid phase compositions reported by Gromov (1948) at 18° agree with the other determinations. A variety of methods were used to prepare the solutions and several months were sometimes required to attain equilibrium. Bassett and Goodwin's data are considerably more extensive and more complex than the others. For example K. & H. report the compound $\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 9\text{H}_2\text{O}$, H. & K. call it $\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 6\text{H}_2\text{O}$, but B. & G. believe it to be $5\text{Al}_2\text{O}_3 \cdot 6\text{SO}_3 \cdot 46\text{H}_2\text{O}$. In addition to solid-liquid equilibria, B. & G. found two separate 2-liquid regions (solution plus "glassy" or "gel" solid) and prepared a total of 8 basic sulfates. They present a schematic diagram showing the proposed limits of solubility of each. Both H. & K. and B. & G. review the previously reported compounds in the system. In the tables below, H. & K.'s data were recalculated from the original (see p. 199, 200), and B. & G.'s were selected from the approximately 125 determinations reported.

S0

Formulas are expressed in the ratios $\text{Al}_2\text{O}_3 : \text{SO}_3 : \text{H}_2\text{O}$.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Al_2O_3	SO_3	Solid Phase	Al_2O_3	SO_3	Solid Phase
Results at 20° (K. & H.)			Results at 25° (B. & G.) (Selected data)		
.....	.....	.....	1.39	34.39	1:3:16
.....	.....	.....	5.20	23.93	1:3:16
10.92	24.1	1:3:16	9.08	19.98*	1:3:16
11.62	23.1	1:3:16	10.15	20.50*	1:3:16
12.15	22.2	1:3:16 + 1:2:12	8.56	19.71	1:3:16 + 1:2:11
11.34	21.1	1:2:12	8.62	19.55	1:2:11
.....	.....	.....	7.16	15.11	1:2:11 + 5:6:46
9.0	17.5	1:2:12	8.57	18.11*	5:6:46
6.86	14.0	1:2:12	7.17	14.97	5:6:46
5.14	10.5	1:2:12	5.55	11.13	5:6:46
3.77	7.0	1:2:12	3.79	6.96	5:6:46
3.56	6.4	1:2:12 + 1:1:9	3.76	6.27	5:6:46
2.50	4.9	1:1:9	2.57	3.51	5:6:46
1.69	3.5	1:1:9	2.08	3.74	5:6:46
0.80	1.65	1:1:9	1.24	2.19	5:6:46
			Metastable data		
			9.03	9.33*	5:3:~34
			6.59	6.85*	5:3:~34
			4.00	5.27*	5:3:~34
			2.15	* 3.21*	5:3:~34
			1.25	2.10*	5:3:~34
			0.42	0.82*	5:3:~34

* Metastable

(Cont.)

A1 ALUMINUM

BASIC REGION OF THE SYSTEM $\text{Al}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ (Cont.)

25° Data of Bassett & Goodwin on Two-Liquid Regions

SO	Region I				Region II			
	Solution wt. %		equilibrated "glassy" solid wt. %		Solution wt. %		equilibrated curd wt. %	
	Al_2O_3	SO_3	Al_2O_3	SO_3	Al_2P_3	SO_3	Al_2P_3	SO_3
	13.60	12.82	25.1	18.6	0.0012	0.0017	30.12	8.82
	10.38	9.79	...	...	0.0006	0.0016	42.53	8.19
	4.38	5.46	29.55	19.30	Trace	Trace	13.62	2.34
	2.40	3.42	29.41	16.58	Trace	Trace	8.13	1.36
	0.928	1.67	28.53	16.63	0.0011	0.0025	34.96	5.67
	0.502	1.00	30.12	17.85	0.0005	0.0016	48.83	4.77
	0.212	0.436	28.49	15.79	0.0002	0.0005	44.98	3.32
	0.0133	0.0308	23.25	11.86	Trace	0.02	38.23	2.66
	0.0103	0.021	18.29	9.17				

Results at 40°

(Kremann and Hättinger)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Al_2O_3	SO_3		Al_2O_3	SO_3	
14.9	34.5	1:3:16	7.36	14.0	1:2:12
11.5	24.5	1:3:16	5.38	10.5	1:2:12
11.78	21.0	1:3:16	4.06	7.02	1:2:12
12.29	20.0	1:3:16 + 1:2:12	3.83	6.21	1:2:12
9.93	17.5	1:2:12	2.41	3.66	1:1:9

(Cont.)

BASIC REGION OF THE SYSTEM $\text{Al}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ (Cont.)

Results at 60°

(Kremann and Huttinger)

(Henry and King)

Gms. per 100 gms. sat. sol.		Solid Phase	pH	Gms. per 100 gms. sat. sol.		Solid Phase
Al_2O_3	SO_3			Al_2O_3	SO_3	
15.73	35.0	1:3:16	..	...	...
16.53	29.75	1:3:16	..	...	...
12.57	22.13	1:2:12	..	10.04	22.02	1:2:11
...	...		..	9.71	20.61	1:2:11
...	...		..	9.59	20.46	1:2:11
...	...		2.58	9.58*	19.00	1:2:11
...	...		2.59	9.50*	18.58	1:2:11
...	...		2.53	9.38	19.23	1:2:11 + 1:1:6
9.21	16.90	1:2:12	2.47	9.17	18.95	1:1:6
...	...		2.68	8.43	17.42	1:1:6
...	...		2.78	8.26	17.20	1:1:6
...	...		2.78	7.27	15.23	1:1:6
...	...		3.00	6.85	14.33	1:1:6
...	...		2.95	6.24	13.21	1:1:6
...	...		3.04	5.92	12.59	1:1:6
...	...		3.05	5.20	10.99	1:1:6
4.98	8.89	1:2:12	3.13	4.86	10.34	1:1:6
4.27	6.19	1:2:12	3.20	3.97	8.41	1:1:6
1.45	2.27	1:1:9	3.55	2.46	5.10	1:1:6

SO

The System $\text{Al}_2(\text{SO}_4)_3 - \text{Al}_2(\text{SeO}_4)_3 - \text{H}_2\text{O}$ at 20° is outlined by Collet 1949, 1949a. Only the pure phases $\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$ and $\text{Al}_2(\text{SeO}_4)_3 \cdot 22\text{H}_2\text{O}$ are present.

THE SYSTEM ALUMINUM SULFATE - COPPER SULFATE - WATER

Results at 25°

(Ocolessaw, 1925; Smith, 1942)

Smith found the hydrate to be

 $\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$

Results at 30°

(Caven and Mitchell, 1925)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuSO_4	$\text{Al}_2(\text{SO}_4)_3$		CuSO_4	$\text{Al}_2(\text{SO}_4)_3$	
0.0	27.80	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	0.0	28.86	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
1.28	27.02	"	3.39	26.83	"
2.50	26.60	"	5.74	25.22	"
3.83	25.64	"	6.30	24.64	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
4.46	25.04	"	7.67	22.00	"
5.18	24.86	" + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	9.79	17.65	"
5.32	24.65	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	12.13	13.80	"
6.11	23.18	"	16.70	5.97	"
8.18	18.83	"	18.65	2.75	"
11.33	13.05	"	20.33	0.00	"
14.69	7.50	"			
16.59	3.79	"			
18.49	0.00	"			

A1 ALUMINUM

THE SYSTEM ALUMINUM SULFATE - FERROUS SULFATE - WATER AT 25° (Occlesshaw, 1925; Smith, 1942)

Smith found the aluminum sulfate hydrate to be $\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$

	Gms. per 100 gms. sat. sol.		Solid Phase
	FeSO_4	$\text{Al}_2(\text{SO}_4)_3$	
	0.0	27.85	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
	0.5447	27.33	"
	1.268	26.96	"
	2.11	26.75	"
	2.415	26.33	"
	3.198	25.69	"
	3.85	25.64	"
	4.13	25.41	" + $\text{Al}_2(\text{SO}_4)_3 \cdot \text{FeSO}_4 \cdot 24\text{H}_2\text{O}$
	4.19	25.21	$\text{Al}_2(\text{SO}_4)_3 \cdot \text{FeSO}_4 \cdot 24\text{H}_2\text{O}$
	5.57	23.90	"
	6.60	23.20	"
	7.12	22.64	"
	8.06	21.62	"
	9.36	20.80	"
	10.17	20.16	" + $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
	10.60	19.37	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
	15.05	12.29	"
	15.57	11.51	"
	18.68	6.98	"
	19.14	6.06	"
	22.98	0.00	"

THE SYSTEM ALUMINUM SULFATE - NICKEL SULFATE - WATER (Smith, 1942 (25°); Caven and Mitchell, 1925a (30°))

Al-17 = $\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$ Al-18 = $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ Ni-7 = $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$

Results at 25°					Results at 30°				
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			
NiSO_4	$\text{Al}_2(\text{SO}_4)_3$	Solid Phase	NiSO_4	$\text{Al}_2(\text{SO}_4)_3$	Solid Phase	NiSO_4	$\text{Al}_2(\text{SO}_4)_3$	Solid Phase	
0.0	27.85	Al-17	0.00	28.86	Al-18	17.53	15.29	Ni-7	
0.846	27.09	"	4.74	25.87	"	22.56	8.70	"	
1.743	26.70	"	10.87	21.95	"	23.58	7.34	"	
3.982	25.22	"	12.91	21.30	Al-18 + Ni-7	26.03	5.29	"	
6.023	23.74	"	13.29	20.79	Ni-7	30.77	0.00	"	

THE SYSTEM ALUMINUM SULFATE - MANGANESE SULFATE - WATER AT 30°
(Caven and Mitchell, 1925)

Gms. per 100 gms. sat. sol.		Solid Phase
MnSO ₄	Al ₂ (SO ₄) ₃	
0.0	28.86	Al ₂ (SO ₄) ₃ ·18H ₂ O
7.41	24.42	"
11.09	21.93	"
12.14	21.13	"
15.23	19.59	" + Al ₂ (SO ₄) ₃ ·MnSO ₄ ·22H ₂ O
15.96	18.11	Al ₂ (SO ₄) ₃ ·MnSO ₄ ·22H ₂ O
19.91	15.01	Al ₂ (SO ₄) ₃ ·MnSO ₄ ·22H ₂ O
27.39	10.40	"
31.43	8.43	"
32.97	7.21	" + MnSO ₄ ·5H ₂ O
37.94	2.47	MnSO ₄ ·5H ₂ O
40.03	0.00	"

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THE SYSTEM ALUMINUM SULFATE - MAGNESIUM SULFATE - WATER AT 25°
(Bassett and Watt, 1950)

1:1:22 = MgSO₄·Al₂(SO₄)₃·22H₂O

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
MgSO ₄	Al ₂ (SO ₄) ₃	Solid Phase	MgSO ₄	Al ₂ (SO ₄) ₃	Solid Phase
27.60	0.0	MgSO ₄ ·7H ₂ O	11.72	19.12	1:1:22
22.69	5.40	"	10.29	20.50	1:1:22 + Al ₂ (SO ₄) ₃ ·16H ₂ O
19.30	10.18	"	10.18	20.66	Al ₂ (SO ₄) ₃ ·16H ₂ O
15.24	16.09	MgSO ₄ + 1:1:22	8.39	21.92	"
14.63	16.38	1:1:22	3.45	25.48	"
12.71	18.19	"	0.0	28.20	"

THE SYSTEM ALUMINUM SULFATE - FERRIC SULFATE - WATER
(Funaki, 1950 (20°, 30°, 40°, 50°); Wirth and Bakke, 1914 (25°))

Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Al}_2(\text{SO}_4)_3$	$\text{Fe}_2(\text{SO}_4)_3$	
Results at 20°		
26.69	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
26.10	1.868	"
23.76	5.436	"
20.10	8.575	"
17.05	11.38	"
14.08	14.88	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
13.32	15.56	"

(Cont.)

Al ALUMINUM

Gms. per 100 gms. sat. sol.

$\text{Al}_2(\text{SO}_4)_3$ $\text{Fe}_2(\text{SO}_4)_3$ Solid Phase

Results at 20° (Contd.)

9.442	16.89	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
7.330	18.13	"
4.701	22.71	} (?) " + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
5.703	20.63	
3.658	25.88	$\text{Fe}(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
3.118	27.23	"
1.119	35.38	"

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Results at 25°

27.82	0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
26.01	6.064	"
24.21	9.819	"
21.64	13.02	"
15.22	23.28	"
10.46	31.90	" + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
10.03	32.42	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
8.819	34.02	"
6.626	35.82	"
5.200	38.83	"
2.342	42.44	"
....	44.97	"

Results at 30°

28.97	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
26.68	3.590	"
21.80	7.803	"
17.95	12.50	" + $\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
11.31	16.97	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
7.501	20.50	"
5.613	23.69	"
4.024	26.23	" + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
4.037	25.18	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
5.661	35.21	"
3.735	26.25	"
3.796	27.95	"
2.517	31.10	"
0.0	39.25	"

Results at 40°

30.15	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
27.75	2.040	"
26.77	2.262	"
24.98	5.405	"
23.07	8.198	"
21.68	8.937	"
20.69	11.25	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
18.48	13.20	"
16.86	16.18	"
16.01	16.73	"

(Cont..)

Gms. per 100 gms. sat. sol.

 $\text{Al}_2(\text{SO}_4)_3$ $\text{Fe}_2(\text{SO}_4)_3$

Solid Phase

Results at 40°(Contd.)

13.10	20.12	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
10.69	23.35	" + $\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$
9.346	26.39	$\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$
8.430	27.54	"
7.289	28.51	" + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
6.852	30.29	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
5.102	30.53	"
2.551	30.81	"
2.349	32.69	"
0.0	40.03	"

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Results at 50°

34.30	0.0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
30.30	2.282	"
25.80	6.028	"
23.18	9.078	"
23.38	9.898	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$
20.56	12.14	"
19.94	13.85	"
16.81	17.50	"
15.10	19.46	"
11.10	23.85	$\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$
10.48	23.36	"
9.767	26.73	"
8.262	29.25	" + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
4.812	30.23	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
4.902	30.73	"
3.490	31.53	"
1.324	34.78	"
0.0	41.65	"

A1 ALUMINUM

THE SYSTEM ALUMINUM SULFATE - POTASSIUM SULFATE - WATER

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
K_2SO_4	$Al_2(SO_4)_3$	Solid Phase	K_2SO_4	$Al_2(SO_4)_3$	Solid Phase
Results at 0° (Ts'ai and Yen, 1936)					
0.0	23.92	$Al_2(SO_4)_3 \cdot 18H_2O$	0.721	2.32	$Al_2K_2(SO_4)_4 \cdot 24H_2O$
0.078	24.07	" + $Al_2K_2(SO_4)_4 \cdot 24H_2O$	0.945	1.82	"
0.096	22.73	$Al_2K_2(SO_4)_4 \cdot 24H_2O$	1.313	1.46	"
0.096	21.64	"	1.574	1.28	"
0.107	19.89	"	2.014	1.08	"
0.151	18.10	"	2.545	0.90	"
0.164	16.28	"	3.040	0.75	"
0.180	13.80	"	3.640	0.59	"
0.145	11.31	"	4.178	0.46	"
0.132	8.47	"	4.733	0.34	"
0.158	6.99	"	5.499	0.28	"
0.193	5.40	"	6.372	0.20	"
0.290	4.48	"	6.961	0.14	" + K_2SO_4
0.414	3.66	"	6.936	0.07	K_2SO_4
0.605	2.84	"	6.89	0.0	"

Results at 25° (Britton, 1922)

0.00	27.70	$Al_2(SO_4)_3 \cdot 18H_2O$	2.05	4.74	$K_2Al_2(SO_4)_4 \cdot 24H_2O$
0.98	23.02	"	2.27	4.47	"
1.93	30.27	" + $K_2Al_2(SO_4)_4 \cdot 24H_2O$	2.99	3.58	"
1.94	27.86	$K_2Al_2(SO_4)_4 \cdot 24H_2O$	3.61	2.99	"
1.46	15.98	"	5.73	2.03	"
1.45	11.28	"	7.25	1.85	"
1.50	10.22	"	10.60	1.45	"
1.72	8.43	"	11.47	1.35	" + K_2SO_4
1.78	7.07	"	10.69	0.76	K_2SO_4
1.87	6.13	"	10.75	0.00	"

Composition of solutions saturated with two solids: (Marino, 1905)

$Al_2(SO_4)_3 \cdot 18H_2O + K_2Al_2(SO_4)_4 \cdot 24H_2O$			$K_2Al_2(SO_4)_4 \cdot 24H_2O + K_2SO_4$		
Gms. per 1000 gms. H_2O			Gms. per 1000 gms. H_2O		
t°	$Al_2(SO_4)_3 \cdot 18H_2O$	K_2SO_4	t°	$Al_2(SO_4)_3 \cdot 18H_2O$	K_2SO_4
0	243.73	23.45	0	5.06	75.83
20	824.25	30.85	0.5	8.66	75.18
35	911.02	35.29	5	16.07	85.78
50	1243.21	59.55	10	18.52	96.50
65	1598.00	119.43	15	20.56	109.30
77	1872.11	183.80	30	39.60	147.8
			40	73.88	163.1
			50	126.0	195.4
			60	249.7	238.8
			70	529.0	323.7
			80	1044.0	517.27

THE SYSTEM ALUMINUM SULFATE - LITHIUM SULFATE - WATER

Results at 0°

(Horan and Skarulis, 1939; Horan and Duane, 1941)

The double salt is incongruently soluble and is stable only over a very small range of concentrations. It was not found by previous workers.

Gms. per 100 gms. sat. sol.		Solid Phase	
$\text{Al}_2(\text{SO}_4)_3$	Li_2SO_4		
0.0	26.50	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	SO
1.90	25.08	"	
7.27	21.21	"	
10.48	18.19	"	
15.17	15.55	"	
16.65	14.63	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O} + \text{LiAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	
17.23	14.11	$\text{LiAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	
17.31	13.94	"	
17.85	13.28	"	
18.06	13.06	$\text{LiAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O} + \text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$	
16.83	14.45*	$\text{Li}_2\text{SO}_4 + \text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$	
17.76	13.07*	$\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$	
18.17	12.92	"	
21.56	7.86	"	
23.78	4.64	"	
25.74	2.30	"	
27.50	0.0	"	

*metastable

A1 ALUMINUM

Earlier work of Sanders and Dobbins, 1931 at 0°

Solid phase $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$				Solid phase $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$			
Sat. sol. wt. %		Sat. sol. wt. %		Sat. sol. wt. %		Sat. sol. wt. %	
Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$
0.0	27.02	10.10	19.31	15.90	16.10	20.09	7.49
0.99	26.30	10.61	19.31	17.05	13.35	20.67	6.39
4.51	23.30	11.40	18.14	18.52	11.43	21.96	4.73
8.63	20.15	12.80	17.80	19.59	9.09	23.39	2.31
		14.65	16.60			25.43	0.0

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At other temperatures the composition of the solution simultaneously saturated with both salts is as follows: (Sanders and Dobbins, 1931)

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	
25	13.55	19.75	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O} + \text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
50	11.93	24.74	" + "

Results at 30°
(Schreinemaker and De Waal, 1906)

Gms. per 100 gms. sat. sol.		Solid Phase
Li_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	
25.1	0	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
21.93	5.34	"
16.10	14.89	"
13.63	20.76	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O} + \text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
13.24	21.71	$\text{Li}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$
11.73	22.08	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
6.75	24.34	"
3.44	26.12	"
0.0	28.0	"

THE SYSTEM ALUMINUM SULFATE - AMMONIUM SULFATE - WATER
(Hill and Kaplan, 1938 (25°); Funaki, 1950 (30°, 40°, 50°))

Gms. per 100 gms. sat. sol.		
$(\text{NH}_4)_2\text{SO}_4$	$\text{Al}_2(\text{SO}_4)_3$	Solid Phase
Results at 25°		
0.0	27.39	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
0.02	27.29	" + $\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
0.125	21.18	$\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
0.352	14.81	"
0.550	14.45	"
0.973	7.497	"
1.439	4.630	"
2.014	3.875	"
8.753	1.190	"
14.72	0.845	"
21.13	0.726	"
32.69	0.463	"
42.78	0.332	" + $(\text{NH}_4)_2\text{SO}_4$
43.32	0.00	$(\text{NH}_4)_2\text{SO}_4$
Results at 30°		
0.0	29.76	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
0.062	29.08	" + $\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
0.601	22.31	$\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
1.060	10.94	"
2.355	6.103	"
12.23	2.116	"
27.85	0.893	"
37.53	0.655	$\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
41.78	0.603	"
43.43	0.577	" + $(\text{NH}_4)_2\text{SO}_4$
43.71	0.333	$(\text{NH}_4)_2\text{SO}_4$
43.90	0.142	"
44.10	0.025	"
44.26	0.0	"
Results at 40°		
0.0	31.23	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
0.117	30.67	" + $\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
0.613	24.15	$\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
1.226	15.48	"
1.812	10.38	"
2.029	8.774	"
3.133	8.222	"
7.769	3.127	"
24.54	1.747	"
34.01	1.594	"
43.81	1.379	" + $(\text{NH}_4)_2\text{SO}_4$
44.00	1.097	$(\text{NH}_4)_2\text{SO}_4$
44.59	0.415	"
45.02	0.0	"

(Cont.)

A1 ALUMINUM

Results at 50°

80

Gms. per 100 gms. sat. sol.		Solid Phase
$(\text{NH}_4)_2\text{SO}_4$	$\text{Al}_2(\text{SO}_4)_3$	
0.0	33.16	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
0.234	32.18	" + $\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
0.668	23.78	$\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
1.066	20.85	"
1.422	19.37	"
3.700	9.096	"
10.65	5.258	"
19.51	4.087	"
34.26	3.462	"
39.96	3.255	"
44.46	2.438	" + $(\text{NH}_4)_2\text{SO}_4$
45.03	1.609	$(\text{NH}_4)_2\text{SO}_4$
45.48	0.613	"
45.91	0.0	"

THE SYSTEM ALUMINUM SULFATE - SODIUM SULFATE - WATER (Dobbins and Addleston, 1935; Dobbins and Byrd, 1931; Skarulis, Horan and Maleeny, 1954)

The results of Dobbins and Addleston and Dobbins and Byrd for the solubility of $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ in water are higher than reported by other investigators, hence it is possible that their results are subject to slight revision downward. Skarulis, Horan and Maleeny found that the sodium alum exists down to 0°. The system was also studied by Collett, 1949 at 20°.

Data for the system at 5°, 18° and 42° are given by Monsseron and Gravier, 1932, but their results are expressed in terms which do not permit of recalculation to the weight percentage basis.

Data for the system at 30°, 42° and 50°, but using as the liquid phase, 10 percent aqueous sulfuric acid instead of water, are given by Dobbins and Thomas, 1937.

Gms. per 100 gms. sat. sol.		Solid Phase
Na_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	
Results at 0° (Dobbins, Addleston, Byrd)		
0.0	27.97	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
1.31	26.42	"
2.12	25.55	" + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
2.88	24.33	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
3.85	22.25	"
4.38	14.99	"
5.02	9.33	"
5.80	5.20	"
6.45	0.0	"

Gma. per 100 gms. sat. sol.		Solid Phase
Na_2SO_4	$\text{Al}_2(\text{SO}_4)_3$	
Results at 0° (Skarulis, Horan, Maleeny)		
0.435	27.34	$\text{Al}_2(\text{SO}_4)_3 \cdot 17\text{H}_2\text{O}$
1.00	27.14	" + $\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
1.87	25.55	$\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
1.93	24.68	"
2.09	24.13	"
3.35	22.16	"
7.37	17.62*	"
3.73	21.58	" + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$

30

*metastable

Results at 25° (D., A., B.)		
0.0	29.29	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
2.27	27.64	"
3.92	26.68	"
6.29	23.07	$\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
10.74	18.66	"
13.70	16.24	"
16.30	14.63	"
18.89	12.80	" + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
19.06	9.18	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
19.85	6.83	"
21.55	0.0	"

Results at 30° (D., A., B.)		
0.0	31.99	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
1.55	31.21	"
2.30	30.87	" + $\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
3.18	29.56	$\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
9.20	22.68	"
15.95	17.73	"
26.67	11.73	" + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
27.07	8.77	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
27.75	5.14	"
29.61	0.00	"

0.0	34.24	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
1.89	32.21	" + $\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
5.49	26.94	$\text{AlNa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
10.31	21.35	"
18.74	15.19	"
25.70	12.43	" + Na_2SO_4
27.13	10.11	Na_2SO_4
29.10	6.83	"
32.94	0.0	"

A1 ALUMINUM

THE SYSTEM ALUMINUM SULFATE - THALLIUM SULFATE - WATER AT 25° (Hill, Smith, and Ricci, 1940)

Gms. per 100 gms. sat. sol.		Solid Phase
Tl_2SO_4	$Al_2(SO_4)_3$	
0.0	27.83	$Al_2(SO_4)_3 \cdot 17H_2O$
.116	27.63	" + $AlTi(SO_4)_2 \cdot 12H_2O$
.391	20.37	$AlTi(SO_4)_2 \cdot 12H_2O$
1.341	9.82	"
3.502	3.343	"
4.743	2.460	"
5.769	2.042	" + Tl_2SO_4
5.590	1.294	Tl_2SO_4
5.212	0.0	"

30

ALUMS	CAESIUM	$AlCs(SO_4)_2 \cdot 12H_2O$
	POTASSIUM	$AlK(SO_4)_2 \cdot 12H_2O$
	AMMONIUM	$AlNH_4(SO_4)_2 \cdot 12H_2O$
	SODIUM	$AlNa(SO_4)_2 \cdot 12H_2O$
	RUBIDIUM	$AlRb(SO_4)_2 \cdot 12H_2O$
	THALLIUM	$AlTi(SO_4)_2 \cdot 12H_2O$

SOLUBILITY OF CAESIUM ALUM, RUBIDIUM ALUM, AND OF THALLIUM ALUM IN WATER

The data of Satterburg, 1892; Locke, 1901; Berkeley 1904; and Hart and Huselton, 1914 agree well and the averages of their results are given. A single determination by Hill, Smith and Ricci, 1940 (6.99) agrees with that of Fock, 1897 (7.07) for thallium alum at 25°.

t°	Caesium Alum Gms. per 100 Gms. H ₂ O		Rubidium Alum Gms. per 100 Gms. H ₂ O		Thallium Alum Gms. per 100 Gms. H ₂ O	
	$AlCs(SO_4)_2$	$AlCs(SO_4)_2 \cdot 12H_2O$	$AlRb(SO_4)_2$	$AlRb(SO_4)_2 \cdot 12H_2O$	$AlTi(SO_4)_2$	$AlTi(SO_4)_2 \cdot 12H_2O$
0	0.21	0.34	0.72	1.21	3.15	4.84
5	0.25	0.40	0.86	1.48	3.80	5.86
10	0.30	0.49	1.05	1.81	4.60	7.12
20	0.40	0.65	1.50	2.59	6.40	10.00
25	0.50	0.91	1.80	3.12	7.60	11.95
30	0.60	0.97	2.20	3.82	9.38	14.89
40	0.85	1.38	3.25	5.69	14.40	23.57
50	1.30	2.11	4.80	8.50	22.50	38.41
60	2.00	3.27	7.40	13.36	35.36	65.19
70	3.20	5.27	12.40	23.25	...	...
80	5.40	9.01	21.60	43.25	...	...
90	10.50	18.11	...	...	...	...
100	22.70	42.54	...	...	...	...

SOLUBILITY OF POTASSIUM ALUM IN WATER

(Mulder, 1864; Poggiale, 1843; Locke, 1901; Marino, 1905;
Berkeley, 1904; Fock, 1897; Flo tman, 1928;
Schlain, Prater and Ravitz, 1947; Hill, Smith and Ricci, 1940)

The data of Schlain, Prater and Ravitz, 1947 (in which equilibrium was approached from both under and supersaturation) are about 0.4% lower than the values given below, up to 45°. The value of Hill, Smith and Ricci (1940) at 25° is also lower than the earlier data. From 45-80° the agreement of all workers except Marino is good. Unless otherwise specified the data were read from the average curve of the various results.

Data for the influence of pressure on the solubility of potassium alum in water at 0° are given by Stackelberg, 1896. 30

t°	Gms. $\text{AlK}(\text{SO}_4)_2$ per 100 gms. sat. sol.	density (Berkeley, S.P.&R.)	Gms. $\text{AlK}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ which will dissolve in 100 gms. H_2O
0	3.0 (2.63)*	1.028	5.65
5	3.5	...	6.62
10	4.0 (3.75)*	1.029	7.60
15	5.0	...	9.59
20	5.9 (5.24)*	1.052	11.40
25	7.23(6.83)* (6.59)**	1.059	14.14
30	8.39	...	16.58
35	(8.75)*	...	23.83
40	11.70	...	...
45	13.16*	1.111	...
50	17.00	...	36.40
55	20.43*	1.155	...
60	24.75	...	57.35
65	31.45*	1.215	...
70	40.0	...	110.5
75	53.7*	1.297	...
80	71.0	...	321.3
85	128.5*	1.444	...
90	109.0	...	2275.0
92.5	119.0	...	∞

*Schlain Prater and Ravitz, 1947.

**Fock, 1897; Hill, Smith and Ricci, 1940.

SOLUBILITY OF AMMONIUM ALUM IN WATER

(Mulder, 1864; Poggiale, 1843; Locke, 1901; Marino, 1905;
Berkeley, 1904; Schlain, Prater and Ravits, 1947)

The more recent data of Schlain, Prater and Ravita (1947), obtained from both under and supersaturation differ considerably from the average values of older workers, and both are given for comparison.

A1 ALUMINUM

t°	Gms. $\text{AlNH}_4(\text{SO}_4)_2$ per 100 gms. sat. sol.			t°	Gms. $\text{AlNH}_4(\text{SO}_4)_2$ per 100 gms. sat. sol.		
	older work	S.P.R.	density (S.P.R.)		older work	S.P.R.	density (S.P.R.)
0	2.10	2.97	1.026	40	14.88	...	...
5	3.50	...	...	45	...	14.41	1.096
10	4.99	4.13	1.035	50	20.18	...	...
15	6.25	...	...	55	...	22.0	1.130
20	7.74	5.91	1.046	60	26.70	...	...
25	9.19	7.84	1.052	65	...	33.5	1.179
SO		(6.60)*		75	...	55.2	1.241
		(6.56)**		85	...	117.3	1.331
30	10.94	...	...	95	109.7	...	...
35	...	9.67	1.070				

SOLUBILITY OF SODIUM ALUM IN WATER (Smith, 1909; Mousseron and Gravier, 1932; Hill & Kaplan, 1938)

The results do not agree with the 25° sodium alum solubility data in contact with its saturated solution at 25°. The temperature has not been determined.

t°	Gms. $\text{AlNa}(\text{SO}_4)_2$ per 100 gms. sat. sol.			t°	Gms. $\text{AlNa}(\text{SO}_4)_2$ per 100 gms. sat. sol.		
	Smith	M.&G.	d ₁₅ sat. sol. (M.&G.)		Smith	M.&G.	d ₁₅ sat. sol. (M.&G.)
0	...	27.24	1.264	25	30.1*	28.96	1.313
5	...	28.18	1.279	30	31.4	29.45	...
10	26.9	28.23	1.295	35	...	30.03	1.336
15	27.9	28.28	1.303	38	...	30.21	1.351
20	29	28.43	...	45	...	28.98	1.317

*at 25° Hill and Kaplan found 30.65%.

TERNARY SYSTEMS INVOLVING ALUMS THE SYSTEM ALUMINUM THALLIUM SULFATE - ALUMINUM AMMONIUM SULFATE - WATER AT 25° (Hill, Smith, and Ricci, 1940)

Sat. Sol. Wt. %		Solid Wt. %		Solid Phase
$\text{TlAl}(\text{SO}_4)_2$	$\text{NH}_4\text{Al}(\text{SO}_4)_2$	$\text{TlAl}(\text{SO}_4)_2$	$\text{NH}_4\text{Al}(\text{SO}_4)_2$	
6.988	0.0	66.20	0.0	$\text{TlAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
6.045	7.23	62.53	2.992	Solid Solution
4.558	2.039	55.71	8.42	"
3.387	3.107	45.62	16.31	"
2.387	4.004	36.27	23.24	"
1.536	4.780	24.74	32.72	"
0.689	5.563	14.17	41.34	"
0.0	6.15	0.0	52.31	$\text{NH}_4\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$

THE SYSTEM ALUMINUM THALIUM SULFATE ALUMINUM
POTASSIUM SULFATE - WATER AT 25°
(Fock, 1897; Hill, Smith, and Ricci, 1940)

Fock's data are more extensive, but more irregular than the later work.

Data of Fock

Gms. per liter sat. sol.		density	Mole %	
AlK(SO ₄) ₂	AlTl(SO ₄) ₂		AlK(SO ₄) ₂ in solid	
69.90	0.00	1.0591	100.0	30
74.56	0.48	1.0601	99.32	
67.90	1.72	1.0598	96.84	
65.30	4.52	1.0603	90.84	
64.95	9.60	1.0605	82.94	
53.23	18.44	1.0609	68.24	
45.32	24.00	1.0609	58.23	
38.02	32.48	1.0611	46.72	
34.54	35.59	1.0611	44.23	
28.35	42.99	1.0623	32.07	
10.94	66.12	1.0654	7.94	
0.00	75.46	1.0674	0.00	

Data of Hill, Smith, & Ricci

Sat. Sol. Wt. %		Solid Wt. %		Solid Phase
AlAl(SO ₄) ₂	KAl(SO ₄) ₂	TlAl(SO ₄) ₂	KAl(SO ₄) ₂	
6.989	0.0	66.20	0.0	TlAl(SO ₄) ₂ ·12H ₂ O
4.202	2.519	51.43	11.97	Solid Solution
2.606	4.020	37.28	23.56	"
1.321	5.280	21.42	36.73	"
0.403	6.17	7.035	48.28	"
0.0	6.59	0.0		AlK(SO ₄) ₂ ·12H ₂ O

Part of the quaternary system AlK(SO₄)₂-NH₄Fe(SO₄)₂-H₂O was studied by Hill, Smith, and Ricci, 1940 and showed a continuous series of solid solutions.

THE SYSTEM ALUMINUM AMMONIUM SULFATE - ALUMINUM
POTASSIUM SULFATE - WATER AT 25°
(Hill and Kaplan, 1938)

Sat. Solution Wt. %		Solid Solution Wt. %		Solid Phase
AlK(SO ₄) ₂	AlNH ₄ (SO ₄) ₂	AlK(SO ₄) ₂	AlNH ₄ (SO ₄) ₂	
0.0	6.19	0.0	52.32	AlNH ₄ (SO ₄) ₂ ·12H ₂ O
1.706	4.632	12.32	40.51	Solid Solution
3.270	3.144	27.20	26.32	"
4.876	1.609	40.15	13.74	"
6.60	0.0	54.47	0.0	AlK(SO ₄) ₂ ·12H ₂ O

THE SYSTEM ALUMINUM AMMONIUM SULFATE - ALUMINUM
SODIUM SULFATE - WATER AT 25°
(Hill and Kaplan, 1938)

Sat. Solution Wt. %		Solid Phase
AlNa(SO ₄) ₂	AlNH ₄ (SO ₄) ₂	
0.0	6.19	AlNH ₄ (SO ₄) ₂ ·12H ₂ O
6.823	3.459	"
11.1	2.339	"
16.4	1.600	"
22.5	0.499	"
30.64	0.99	AlNH ₄ (SO ₄) ₂ ·12H ₂ O + AlNa(SO ₄) ₂ ·12H ₂ O
30.65	0.0	AlNa(SO ₄) ₂ ·12H ₂ O

THE SYSTEM ALUMINUM AMMONIUM SULFATE - FERRIC
AMMONIUM SULFATE - WATER AT 25°
(Hill and Kaplan, 1938)

Sat. solution Wt. %		Solid solution Wt. %		Solid Phase
FeNH ₄ (SO ₄) ₂	AlNH ₄ (SO ₄) ₂	FeNH ₄ (SO ₄) ₂	AlNH ₄ (SO ₄) ₂	
0.0	6.19	0.0	52.32	AlNH ₄ (SO ₄) ₂ ·12H ₂ O
6.12	4.15	0.40	52.00	Solid Solution
11.12	2.76	4.28	48.22	"
16.37	1.92	10.38	42.62	"
18.94	1.59	12.50	40.50	"
21.54	1.08	19.66	33.74	"
23.31	0.620	25.85	27.85	"
24.97	0.301	26.84	26.96	"
26.31	0.295	30.18	23.72	"
26.79	0.172	34.08	19.92	"
27.06	0.219	37.11	17.19	"
28.29	...	38.50	16.00	"
28.55	...	41.88	12.72	"
28.49	...	47.10	7.70	"
30.85	0.0	55.16	0.0	FeNH ₄ (SO ₄) ₂ ·12H ₂ O

The quaternary system $2\text{Al}_2(\text{SO}_4)_3 + 3\text{Na}_2\text{SeO}_4 \rightleftharpoons 2\text{Al}_2(\text{SeO}_4)_3 + 3\text{Na}_2\text{SO}_4$ in water at 20° has been outlined by Collet, 1949. The solid phases present are $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$, $\text{Al}_2(\text{SeO}_4)_3 \cdot 22\text{H}_2\text{O}$, mixed crystals of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{Na}_2\text{SeO}_4 \cdot 10\text{H}_2\text{O}$, $\text{Al}_2(\text{SO}_4)_3 \cdot \text{Na}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$, and $\text{Al}_2(\text{SeO}_4)_3 \cdot \text{Na}_2\text{SeO}_4 \cdot 22\text{H}_2\text{O}$. Similar data for the system $2\text{Al}_2(\text{SO}_4)_3 + 3\text{K}_2\text{SeO}_4 \rightleftharpoons 2\text{Al}_2(\text{SeO}_4)_3 + 3\text{K}_2\text{SO}_4$ are given by Collet 1949a.

THE SYSTEM ALUMINUM SULFATE - ETHANOL - WATER
(Gee, 1945)

0 = $\text{Al}_2(\text{SO}_4)_3$

10 = $\text{Al}_2(\text{SO}_4)_3 \cdot 10\text{H}_2\text{O}$

16 = $\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$

Brackets indicate a two-liquid system, T = top layer, B = bottom layer

Results at 30°

Gms. per 100 gms. sat. sol.			Solid Phase	
$\text{Al}_2(\text{SO}_4)_3$	$\text{C}_2\text{H}_5\text{OH}$	Density		
0.1	99.8	0.781	0	
.1	96.0	0.790	0 + 10	
0.1	95.1	0.791	"	
0.0	92.6	0.800	"	
0.0	90.8	0.804	"	
0.0	83.5	0.824	"	
0.0	77.5	0.841	"	
0.0	70.1	0.861	"	
0.0	69.1	0.863	"	
0.0	67.8	0.867	"	
0.0	66.4	0.870	10 + 16	
0.0	64.0	0.878	16	
0.1	62.4	0.881	"	
0.2	59.4	0.882	"	
0.2	58.8	0.892	"	
0.3	56.8	0.898	"	
0.4	53.5	0.908	"	
0.7	51.8	0.913	"	
1.0	49.9	0.919	"	
1.4	46.0	0.924	"	
2.8	40.9	0.935	"	
{ 3.8	38.1	0.947 (T)	"	
{ 11.4	26.1	1.038 (B)	"	
{ 6.9	33.0	0.957 (T)	"	
{ 15.3	20.0	0.990 (B)	"	
19.5	15.5	1.162	"	
20.3	13.0	1.186	"	
22.5	8.1	1.223	"	
26.6	2.0	1.293	"	
27.7	0.0	1.302	"	

Results at 80°

Gms. per 100 gms. sat. sol.			Solid Phase	
$\text{Al}_2(\text{SO}_4)_3$	$\text{C}_2\text{H}_5\text{OH}$	Density		
0.9	98.9	0.745	0	
.7	92.0	0.759	"	
.3	86.3	0.776	"	
.1	83.0	0.783	"	
.0	80.0	0.790	0 + 10	
{ 2.0	63.5	0.840 (T)	"	
{ 38.0	6.9	1.345 (B)	"	
{ 1.9	62.1	0.848 (T)	"	
{ 36.4	7.2	1.320 (B)	"	
{ 2.0	60.8	0.854 (T)	"	
{ 32.8	9.1	1.285 (B)	"	
{ 2.0	60.5	0.856 (T)	"	
{ 32.9	9.0	1.280 (B)	"	
{ 3.0	56.5	0.860 (T)	"	
{ 32.2	9.3	1.230 (B)	"	
{ 3.4	52.4	0.871 (T)	"	
{ 29.4	11.5	1.210 (B)	"	
{ 4.5	50.0	0.903 (T)	"	
{ 28.5	11.5	1.200 (B)	"	
{ 5.5	43.7	0.912 (T)	"	
{ 27.2	12.8	1.152 (B)	"	
{ 6.6	44.0	0.918 (T)	"	
{ 25.0	14.0	1.143 (B)	"	
{ 8.4	38.8	0.964 (T)	"	
{ 23.2	15.5	1.132 (B)	"	
24.0	15.3	1.131	"	
17.5	22.0	1.042	"	
12.3	31.0	0.990	"	
39.4	3.5	...	"	
42.2	0.0	...	"	

SOLUBILITY OF ALUMINUM SULFATE IN METHANOL AND ETHANOL
(Barber and Ali, 1950)

- Grams per liter of sat. soln. -

Solid taken	Solvent 98% Methanol		Solvent 96% Ethanol	
	Room Temp.	Boiling Point	Room Temp.	Boiling Point
$\text{Al}_2(\text{SO}_4)_3$	0.26	1.0	0.20	0.8
$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	0.94	458.	0.15	2.3

(Cont.)

Al ALUMINUM

Data are also given for the compositions of solutions simultaneously saturated with aluminum and beryllium sulfates in methanol - water and ethanol - water mixtures, at 10° and at the boiling points.

(Barber and Ali, 1950)

SOLUBILITY IN GLYCOL

100 gms. glycol dissolve 16.82 gms. $\text{Al}_2(\text{SO}_4)_3$. (de Coninck, 1905.)

ALUMINUM-TETRAMETHYL AMMONIUM SULFATE $\text{Al}_2(\text{SO}_4)_3 \cdot [(\text{CH}_3)_4\text{N}]_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$

At 25°, 40.44 g. of anhydrous salt dissolve per 100 gms. saturated solution in water. Density of sat. soln. = 1.445.

SeO ALUMINUM SELENATE $\text{Al}_2(\text{SeO}_4)_3$

Collet (1949) studied the system $\text{Al}_2(\text{SeO}_4)_3 + \text{Na}_2\text{SeO}_4 + \text{H}_2\text{O}$ at 20° and found the solid phases: $\text{Al}_2(\text{SeO}_4)_3 \cdot 22\text{H}_2\text{O}$, $\text{Al}_2(\text{SeO}_4)_3 \cdot \text{Na}_2\text{SO}_4 \cdot 22\text{H}_2\text{O}$, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. No data are given, but approximate concentrations may be read from the diagram for the quaternary system $\text{Al}_2(\text{SeO}_4)_3 + \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$.

Similar data for the system $\text{Al}_2(\text{SeO}_4)_3 + \text{K}_2\text{SeO}_4 + \text{H}_2\text{O}$ are given by Collet (1949a) and showed the presence of the salt $\text{Al}_2(\text{SeO}_4)_3 \cdot \text{Na}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$. The diagram for the quaternary system $\text{Al}_2\text{SeO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$ is given.

SiO ALUMINUM SILICATES $x\text{Al}_2\text{O}_3 \cdot y\text{SiO}_2 \cdot z\text{H}_2\text{O}$

Several hydrothermal studies of the system $\text{Al}_2\text{O}_3 - \text{SiO}_2 - \text{H}_2\text{O}$ have been made at high temperatures. Roy and Osborn (1952, 1954) studied the system from 100° to 600° and have outlined the regions of stability of the various (at least twelve) phases.

Data for the solubility of dickite, kaolinite, pyrophyllite, and diaspore in 10% NaOH at 80° are given by Nagai and Imai, 1944. The $\text{Al}_2\text{O}_3/\text{SiO}_2$ ratio is the same in the solution as in the original solids.

AMERICIUM CARBONATE $(\text{AmO}_2)_2\text{CO}_3$

SOLUBILITY OF AMERICIUM CARBONATE IN RUBIDIUM CARBONATE SOLUTIONS AT 25° (Nigon, Penneman, Staritsky, Keenan, and Asprey, 1954)

The different values in column one are unexplained.

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. wt. residue		Solid Phase
$(\text{AmO}_2)_2\text{CO}_3$	Rb_2CO_3	$(\text{AmO}_2)_2\text{CO}_3$	Rb_2CO_3	
0.376	6.73	30.12	13.84	$\text{RbAmO}_2\text{CO}_3$
0.0043	5.64	49.97	23.30	"

ARSENIC As

Equilibria in the following systems have been determined:

As + Ag	(Owen and Rowlands, 1940)
As + Cr	(Haraldsen and Nygaard, 1939)
As + Cu	(Owen and Rowlands, 1940)
As + Ge	(Stohr and Klemm, 1940)
As + Si	(Klemm and Pirseher, 1941)
As + Cu + Ni	(Koater and Mulfinger, 1940)
As + Fe	(Sawamura and Mori, 1952)
As + Fe + C	(" " ")
As + I	(Jaeger and Doornbosch, 1912; Ouercigh, 1912)
As + S	(Jonker, 1909)
As + Sb	(Mansuri, 1928)
As + P	(Klemm and von Falkowski, 1948)

ARSENIC Tri BROMIDE AsBr₃

Br

SOLUBILITY IN NITROBENZENE
(Bernstein, 1941)

The author studied the system by thermal and conductimetric methods. The following data were read from the melting point curves given in the paper.

Temp.	Mole % AsBr ₃	Solid Phase	Temp.	Mole % AsBr ₃	Solid Phase
5°	1	C ₆ H ₅ NO ₂	5°	59	AsBr ₃
0°	10	"	10°	67	"
-5°	19	"	15°	74	"
-10°	26	"	20°	80	"
-16°	39	C ₆ H ₅ NO ₂ + AsBr ₃	25°	87	"
-10°	44	AsBr ₃	30°	96	"
-5°	48	"			
0°	52	"			

SOLUBILITY OF
AsBr₃ IN BROMINE
(Pusin and Makuc, 1938)
read from the authors' graph

SOLUBILITY OF
AsBr₃ IN BORON BROMIDE
(Adamsky and Wheeler, 1954)
read from the authors' graph

t°	mole % AsBr ₃	Solid Phase	t°	mole % AsBr ₃	Solid Phase
-10	4	Br ₂	-54	5	AsBr ₃ + BBr ₃
-20	13	"	-30	11.5	AsBr ₃
-31.5	20.5	Br ₂ + AsBr ₃	-20	16	"
-20	26	AsBr ₃	-10	21	"
-10	32	"	0	33	"
0	39	"	10	49	"
+10	51	"	15	60	"
20	67	"	20	81.5	"

As ARSENIC

Melting point data are given for the following systems

AsBr ₃ + AsCl ₃	(1)	AsBr ₃ + Urethan	(4)
" + AsI ₃	(1)	" + Ethyl Urethan	(4)
" + Br	(2)	" + Anilin hydrochloride	(4)
" + BiBr ₃	(2)	" + Phenol	(4)
" + PBr ₃	(2)(6)	" + Resorcinol	(4)
" + PBr ₃	(2)	" + Naphthalene	(5)(7)
" + S ₂ Br ₂	(2)	" + β-Naphthol	(4)
" + SbBr ₃	(2)(4)	" + Trinitrotoluene	(7)
" + SnBr ₄	(2)	" + Azobenzene	(8)
" + TiBr ₄	(3)		

- I (1) Raeder, 1933;
 (2) Pusin and Makne, 1938;
 (3) Ringorn, 1950;
 (4) Pusin and Lowy, 1926;
 (5) Pusin and Kirger, 1914;
 (6) Jaeger and Doornboach, 1912;
 (7) Pushin, Nikolic, et al., 1947;
 (8) Pushin, 1948a.

Cl ARSENIC TRICHLORIDE AsCl₃

When 1.0 gm. of arsenic as the trichloride is dissolved in 100 cc. of aq. HCl, and the solution shaken with 100 cc. of ether the following percentages of the metal enter the ethereal layer; with 20% HCl, 68%; 15% HCl, 37%; 10% HCl, 7%; 5% HCl, 0.7% and with 1% HCl, 0.2% of the arsenic. (Mylius, 1911.)

Melting point data for the following systems have been determined:

AsCl ₃ + CCl ₄	} (Sisler, Pfahler, and Wilson, 1948)
AsCl ₃ + SiCl ₄	
AsCl ₃ + GeCl ₄	
AsCl ₃ + SnCl ₄	
AsCl ₃ + TiCl ₃	(Ringorn, 1950a)
AsCl ₃ + AsI ₃	(Raeder, 1933)
AsCl ₃ + Cl ₂	(Blitz and Meinecke, 1923)
AsCl ₃ + Diphenylamine	} (Pushin and Hrustanovic, 1938, 1948)
AsCl ₃ + o, m, p-Toluidine	
AsCl ₃ + Adamsite	
AsCl ₃ + Trinitrotoluene	(Pushin, Nikolic, et al 1947)
AsCl ₃ + C ₆ H ₅ NH ₂	} (Pushin, 1948a)
AsCl ₃ + CH ₃ C ₆ H ₄ NH ₂	
AsCl ₃ + (CH ₃) ₂ C ₆ H ₃ NH ₂	

F ARSENIC TRIFLUORIDE AsF₃

The extraction of AsF₃ from HF solutions by ethyl ether was studied by Kitahara, 1949.

ARSINE AsH₃

SOLUBILITY OF ARSINE IN WATER

(Soubeiran, 1830; Strohmeyer, Wolff, 1936; Gebert, 1937;
Jung, 1939; Corriez and Berton, 1950)

Soubeiran reported the solubility to be 5 volumes of AsH₃ per volume of H₂O, but did not give the method used nor the purity of the gas. Strohmeyer found $\beta = 0.018$, but the small solubility was probably due to a large amount of hydrogen mixed with the arsine. Wolff liquified his arsine using a mixture of solid carbon dioxide + alcohol, and then distilled it three times at low temperatures. At 20° Wolff found $\beta = 0.195$. Gebert repeated Wolff's experiments, and concluded that Wolff, along with previous workers, was dealing with a mixture of arsine + hydrogen. Gebert liquified the gas with solid carbon dioxide + alcohol and distilled it twice at reduced pressure, using liquid air to cool the receiver. Foreign gases were removed from the solid by pumping at reduced pressure. His value at 20° is $\beta = 0.282$ and is the highest reported. Jung solidified the gas with liquid air, pumped off foreign gases with a high vacuum pump, and stored the arsine as a solid until used. He determined the solubility as a function of temperature, and his data were plotted and the values given below were read from the smoothed curve. Jung attributes the disagreement between his data and Wolff's and Gebert's to poor temperature control on the part of the other authors, and to some small errors due to their methods. Corriez and Berton do not describe the purification of their gas nor do they discuss the earlier work.

β = ml of AsH₃ (measured at S.T.P.) per ml of H₂O at 1 atmosphere, partial pressure of AsH₃.

β				β			
Corriez & Berton				Corriez & Berton			
t°	Gebert	Aireated H ₂ O	H ₂ O without Air	t°	Gebert	Aireated H ₂ O	H ₂ O without Air
0	0.42	..	..	16	...	0.18	0.20
5	0.34	..	..	17	...	0.17	0.19
7	..	0.24	0.28	20	0.23	0.14	0.19
8	..	0.24	0.27		(0.195)*		
10	0.30	..	..		(0.282)†		
15	0.26	0.18	0.21	21	...	0.14	0.15
				25	0.20	..	..

*Wolff

†Jung

As ARSENIC

SOLUBILITY OF ARSINE IN VARIOUS AQUEOUS SOLUTIONS (Jung, 1939)

% NaCl	Temp. °	Bunsen Coeff. β	% NaOH	Temp. °	Bunsen Coeff. β
0.0	22	0.228	2	21.5	0.163
0.45	22	.221	2	20	.163
0.9	20	.286*	4	21.5	.149
2.95	22	.178	4	20	.145
3.9	22	.163	8	21.5	.080
9.5	22	.119	20	21.5	.020
17.6	22	.069	% H_2SO_4		
% $Na_2S_2O_4$			1.2	21.7	.223
1.9	21	.206	6.5	21.5	.173
3.8	20.5	.192	% Glycochol		
% NaOH			0	22.5	.211
0.0	19	.262	1	22.5	.187
.4	21	.216	2	22.5	.175
.8	21	.179	4	22	.137
.8	20.5	.180	10	22	.113

*Gebert, 1937

- The solubility in water decreases as the solution is made acidic (HCl , H_3PO_4), or basic ($NaOH$).
- The solubility in solutions containing blood serum or egg albumin is about the same as the solubility in water.
- The solubility was determined in hematin solutions and suspensions of red blood cells in 0.9% $NaCl$.
- The mechanism of the arsine oxidation in biological solutions is discussed in detail.

-Gebert, 1937

The solubility is correlated with the amount of methemoglobin in solution by Wolff (1936), who also studied the mechanism of arsine oxidation.

Data for the solubility of arsine in water, blood, serums, physiological salt solutions, ether, chloroform, and some salt solutions are given by Meissner (1913).

Jung (1939) gives the solubility of arsine in cattle and pig's blood under varying conditions of time, added materials, dilution, etc., and also summarizes the results of other authors.

SOLUBILITY OF ARSINE IN VARIOUS ORGANIC LIQUIDS (Corriez and Berton, 1950)

Solvent	t°	β	Solvent	t°	β
Acetone, pure	25	9.1	Monoethanolamine (tech)	12	1.75
Acetonitrile	14	5.3	Perchloroethylene	25	11.2
Butyronitrile	14	8.0	Propionitrile	14	7.9
Carbon tetrachloride	25	11.7	Tetrachlorethane	25	9.7
Chloroform	25	10.9	Tetralin (tech.)	25	10.
Dichlorethane	25	8.8	Trichlorethylene	25	12.5
Dichlorethylene	25	12.3	Triethanolamine	12	0.8
Methylene chloride	25	10.7	Vaseline oil	17	8

Solubility of arsine in anhydrous HCN at 14°, $\rho = 0.7$. (Corriez and Berton, 1950).

Melting point data for the system $\text{AsH}_3 - \text{BF}_3$ reveal no compounds. A miscibility gap from 1.3 - 68.4 mol. % BF_3 exists and the eutectic is at -129°, 85 mol. % BF_3 . (Martin and Dial, 1950).

ARSENIC TRIIODIDE AsI_3

SOLUBILITY IN WATER

100 gms. H_2O dissolve about 6 gms. AsI_3 at 25° (U.S.P.).

I

SOLUBILITY IN ORGANIC SOLVENTS

A very careful study by Madson and Krauskopf, 1931, of the preparation of pure AsI_3 , its exact melting point (138.6°), stability and solubility in organic solvents, showed that in each solvent the compound gradually decomposed and saturation could not be obtained even after 4 weeks. The rate of solution with time was greater after 115 hours than after 24 hours stirring. An effort was made to find a solvent in which gradual decomposition did not occur but the only difference was a variable rate of decomposition with each solvent.

t°	Solvent	Gms. AsI_3 per 100 gms. sat. sol.	
30°	Glacial acetic acid (24 hrs. stirring)	0.1	} (Madson and Krauskopf, 1931)
	Glacial acetic acid (115 hrs. stirring)	0.17	
Room	Carbon disulfide	4.96	(Squire and Caines, 1905)
12°	Methylene iodide ($d_{\text{sat. sol.}} = 3.449$)	14.8	(Retgers, 1893)

Melting point data are given for the following systems:

$\text{AsI}_3 + \text{I}$	(Quercigh, 1912; Montignie, 1941)
" + PI_3	(Jaeger and Doornbosch, 1912)
" + SbI_3	(" " ")
" + SnI_4	(Vasilev, 1917)
" + Iodoform	(Hertel, 1932)
" + " + Sulfur	(" ")
" + Naphthalene	(Pushin, 1948a)
" + Phenanthrene	(" ")

As ARSENIC

0 ARSENIC TRIOXIDE As_2O_3

SOLUBILITY IN WATER (Anderson and Story, 1923)

Data in excellent agreement with these are given by Garrett, Holmes and Laube (1940) at 25°, Jozefowicz, Witekowa, and Zubranska (1950) at 25°, Schreinemakers and de Baat (1915) at 20° and 30°, De Carli (1932) at 20°, Bruner and St. Tolloczko (1903), and Chodounsky (1888) at 2°, 15°, 25° and 39.8°. The values of Ragg (1950) at 18° and Wood (1908) at 15° are too low, and that of Schnellbach and Rosin (1929) at 25° too high. For data on different modifications of As_2O_3 , see below.

t°	Gms. As_2O_3 per 100 gms. H_2O	t°	Gms. As_2O_3 per 100 gms. H_2O
0	1.21	39.8	2.93
2	1.20*	48.2	3.43
15	1.66	62	4.45
20	1.81†	75	5.62
25	2.05	98.5	8.18
30	2.31**		

*Bruner and St. Tolloczko, 1903;

†De Carli, 1932;

**Schreinemakers and de Baat, 1915.

An "amorphous" modification has been reported by Winkler (1885), who gives its solubility as 3.7 gms. per 100 cc H_2O at ordinary temperatures, and 11.86 gms. at the boiling point. Margulis (1947), and Margulis and Gane (1947) extracted As_2O_3 with water and found that their results could be explained on the existence of two forms of As_2O_3 existing in the sample. The amount extracted depended upon the number of previous extractions and the amount of solid at the start.

SOLUBILITY OF ARSENIC TRIOXIDE IN ACID SOLUTIONS (Ghiron and Mangili, 1935; Garrett, Holmes and Laube, 1940)

These authors agree reasonably well on the solubility of As_2O_3 in HCl solutions. The results of Wood (1908) at 25° are too low.

Data of Ghiron and Mangili:

t°	Mols. Acid per liter	Gms. As_2O_3 per 100 gms. sat. solution in aq. sol. of:				
		H_3AsO_4	H_3PO_4	H_2SO_4	HCl	$HClO_4$
25	1.0	1.62	1.62	1.55	1.83	1.71
"	5.0	1.10	0.94	0.54	...	0.43
"	7.5	1.23	0.63	0.25	5.02	0.18
60	1.0	3.50	3.50	3.16	3.64	3.47
"	5.0	2.63	2.09	1.19	...	..0
"	7.5	2.10	1.57	0.78	15.43	0.42
98-90	1.0	8.45	8.46	7.27	...	6.69
"	5.0	5.08	4.51	2.62	...	1.88
"	7.5	4.36	3.02	1.48	25.92	0.84

Data of Garrett, Holmes and Laube in HCl solutions:

Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O	
HCl	As ₂ O ₃	HCl	As ₂ O ₃	HCl	As ₂ O ₃
0.0	2.047	3.647	1.812	11.56	1.468
0.1466	1.986	3.775	1.818	12.58	1.525
0.2991	1.988	5.562	1.672	13.68	1.563
0.3756	1.998	7.586	1.622	15.86	1.822
1.109	1.962	9.482	1.614	17.87	1.939
2.564	1.879	10.58	1.592	29.54	9.79

0

SOLUBILITY IN FORMIC AND ACETIC ACID SOLUTIONS

100 gms. 95% formic acid dissolve 0.02 gm. As₂O₃ at 19.8°. (Aschan, 1913.)

Data upon the influence of diols upon the solubility of As₂O₃ in glacial acetic acid are given by Englund, 1930.

SOLUBILITY OF ARSENIC TRIOXIDE IN SODIUM HYDROXIDE SOLUTIONS AT 25° (Garrett, Holmes and Laube, 1940; Schreinmakers and de Baat, 1917) See also sodium arsenite.

Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O	
NaOH	As ₂ O ₃	NaOH	As ₂ O ₃	NaOH	As ₂ O ₃
0.0	0.2047	2.013	1.133	12.00	4.15
0.1200	0.2447	2.81	1.289	17.55*	3.84
0.2801	0.3050	3.609	1.592	24.00	8.39
0.4013	0.3466	4.009	1.788	34.82*	7.79
0.8002	0.510	6.006	2.39	69.9*	11.98
1.200	0.663	8.042	3.22	2.05*	33.0

*Schreinmakers and de Baat

Results very similar to these are reported graphically by Souchay (1951) at 17°. NaNO₃ was added to keep the ionic strength = 1.0 and the solubility in the absence of NaOH was 0.196. The solubility increased linearly up to 1.20 when 0.62 M NaOH (+ 0.38 M NaNO₃) was present.

As ARSENIC

SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS AMMONIA SOLUTIONS AT 30°
(Schreinemakers and deBaat, 1915)

(Interpolated from original results)

	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	NH ₃	As ₂ O ₃		NH ₃	As ₂ O ₃	
	0	2.3	As ₂ O ₃	4	7.6	NH ₄ AsO ₂
	1	8.3	"	5	6.2	"
	2	14.9	"	7	4.6	"
0	2.8	20.5	As ₂ O ₃ + NH ₄ AsO ₂	10	3.1	"
	3	13	NH ₄ AsO ₂	13	2.4	"
	3.5	9.1	"	14.3	2.2	"

SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS SALT SOLUTIONS
(Schreinemakers and deBaat, 1917)

In Aq. Ammonium Bromide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	NH ₄ Br	
2.26	0.0	As ₂ O ₃
2.25	0.339	" + As ₂ O ₃ ·NH ₄ Br
0.679	4.37	As ₂ O ₃ ·NH ₄ Br
0.518	7.18	"
0.386	13.31	"
0.303	20.14	"
0.237	31.69	"
0.154	41.34	"
0.190	45.66	" + NH ₄ Br
0.0	44.8	NH ₄ Br

In Aq. Sodium Bromide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	NH ₄ Br	
2.19	5.57	As ₂ O ₃
2.09	10.89	"
1.88	20.79	"
1.63	30.39	"
1.50	35.75	"
1.20	39.24	(As ₂ O ₃) ₃ NaBr
0.953	43.64	"
0.852	45.99	"
0.719	50.25	" + NaBr·2H ₂ O
0.0	±49.5	NaBr·2H ₂ O

In Aq. Barium Bromide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	BaBr ₂	
2.09	9.41	As ₂ O ₃
2.03	16.88	"
1.97	24.03	"
1.87	24.41	"
1.58	23.49	(As ₂ O ₃) ₂ BaBr ₂
0.757	29.09	"
0.678	33.08	"
0.464	38.19	"
0.322	43.02	"
0.277	50.03	" + BaBr ₂ ·2H ₂ O
0.0	50.62	BaBr ₂ ·2H ₂ O

In Aq. Barium Chloride at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	BaCl ₂	
2.24	3.84	As ₂ O ₃
2.20	8.72	"
2.19	8.86	"
2.15	10.34	"
1.69	9.55	(As ₂ O ₃) ₂ ·BaCl ₂
1.12	13.62	"
0.905	16.93	"
0.737	20.06	"
0.608	23.87	"
0.506	26.54	" + BaCl ₂ ·2H ₂ O
0.0	27.6	BaCl ₂ ·2H ₂ O

In Aq. Calcium Bromide at 20°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	CaBr ₂	
1.58	9.65	As ₂ O ₃
1.28	20.13	"
0.912	34.90	"
0.789	41.00	"
0.698	47.67	"
0.513	52.06	"
0.687	58.22	" + CaBr ₂ ·6H ₂ O
0.0	58.20	CaBr ₂ ·6H ₂ O

In Aq. Calcium Chloride
at 19.5°-20°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	CaCl ₂	
1.78	0.0	As ₂ O ₃
1.39	12.66	"
1.01	23.09	"
0.865	27.68	"
0.757	31.85	"
0.697	36.01	"
0.675	41.92	" + CaCl ₂ ·6H ₂ O
0.0	42.7	CaCl ₂ ·6H ₂ O

In Aq. Lithium Bromide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	LiBr	
2.26	0.0	As ₂ O ₃
1.69	11.68	"
1.20	23.23	"
0.734	35.54	"
0.534	37.00	" + (As ₂ O ₃) ₂ ·LiBr
0.332	42.62	(As ₂ O ₃) ₂ ·LiBr
0.281	43.87	"
0.198	46.75	"
0.0	59.62	LiBr·H ₂ O

In Aq. Lithium Chloride at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	LiCl	
1.69	7.57	As ₂ O ₃
1.15	15.30	"
0.77	22.67	"
0.54	29.04	"
0.43	35.37	"
0.39	41.13	"
0.385	43.01	"
0.41	45.12	" + LiCl·H ₂ O
0.0	46.1	LiCl·H ₂ O

In Aq. Potassium Bromide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	KBr	
2.25	0.336	As ₂ O ₃ + D
0.818	2.51	D
0.460	12.78	"
0.327	22.59	"
0.290	27.40	"
0.275	36.98	"
0.207	39.04	"
0.166	42.07	" + KBr
0.0	41.3	KBr

In Aq. Potassium Iodide at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
As ₂ O ₃	KI	
2.26	0.0	As ₂ O ₃
0.772	1.19	(As ₂ O ₃) ₂ ·KI
0.296	9.56	"
0.183	22.89	"
0.150	34.31	"
0.119	40.79	"
0.081	47.07	"
0.115	53.51	"
0.134	60.54	" + KI
0.0	61.5	KI

D varies from (As₂O₃)₂KBr to (As₂O₃)₇(KBr)₄.

(Cont.)

As ARSENIC

In Aq. Strontium Bromide at 30°

In Aq. Strontium Chloride at 30°

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
As ₂ O ₃	SrBr ₂	Solid Phase	As ₂ O ₃	SrCl ₂	Solid Phase
1.69	11.69	As ₂ O ₃	2.14	6.27	As ₂ O ₃
1.74	22.09	"	1.92	13.67	"
1.48	31.98	"	1.67	21.29	"
1.25	41.91	"	1.46	27.46	"
1.07	46.87	"	1.28	34.03	"
0.991	48.91	" + SrBr ₂ ·6H ₂ O	1.23	36.16	" + SrCl ₂ ·6H ₂ O
0	0.0	SrBr ₂ ·6H ₂ O	0.0	37.5	SrCl ₂ ·6H ₂ O

Data of Jozefowicz, Witekowa and Zubraska, 1950 at 25°:

Normality of added salt	Moles H ₃ AsO ₃ per liter	Normality of added salt	Moles H ₃ AsO ₃ per liter	Normality of added salt	Moles H ₃ AsO ₃ per liter
NaCl Added		MgBr ₂ added		NaNO ₃ added	
0.0	0.2048	0.0	0.2048	0.0	0.2048
0.466	0.2073	0.457	0.1983	0.379	0.2103
0.839	0.2081	0.963	0.1898	0.787	0.2154
1.069	0.2065	1.349	0.1818	0.815	0.2146
1.434	0.2075	2.404	0.1608	1.877	0.2202
1.998	0.2038	3.047	0.1486	2.148	0.2196
2.449	0.2007	3.754	0.1324	2.514	0.2204
2.768	0.1995	4.472	0.1202	3.138	0.2096
3.670	0.1896	4.808	0.1170		
4.198	0.1799			KNO ₃ added	
4.750	0.1775	Mg(NC ₃) ₂ added			
5.396	0.1717			0.203	0.2267
		0.196	0.2113	0.433	0.2372
NH ₄ NO ₃ added		0.341	0.2246	0.669	0.2405
		0.531	0.2108	0.779	0.2446
0.473	0.2007	0.943	0.1956	0.823	0.2455
0.951	0.1902	1.303	0.1802	1.299	0.2423
1.340	0.1864	1.618	0.1639	1.667	0.2460
1.873	0.1845	1.790	0.1595	2.325	0.2261
2.373	0.1766	2.381	0.1352	2.662	0.2129
2.803	0.1770				
		(NH ₄) ₂ SO ₄ added		K ₂ SO ₄ added	
Na ₂ SO ₄ added					
		0.286	0.2310	0.190	0.2294
0.116	0.2031	1.491	0.2694	0.255	0.2303
0.424	0.1995	2.276	0.2821	0.345	0.2246
0.787	0.2072	2.438	0.2793	0.547	0.2332
1.132	0.2070	3.171	0.2823	0.832	0.2324
1.721	0.2029	4.113	0.2930	0.957	0.2329
		MgSO ₄ added			
0.445	0.2239	1.716	0.2214	2.849	0.2096
0.660	0.2247	2.371	0.2144	3.810	0.2042

SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS SOLUTIONS
OF ARSENATES AND PHOSPHATES
(Giron and Monticelli, 1938)

In aqueous solutions of:

t°	Mono potassium Phosphate		Mono potassium Arsenate		Mono sodium Phosphate		Mono sodium Arsenate	
	Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
	KH ₂ PO ₄	As ₂ O ₃	KH ₂ AsO ₄	As ₂ O ₃	NaH ₂ PO ₄	As ₂ O ₃	NaH ₂ AsO ₄	As ₂ O ₃
25	12.706	2.283	17.704	2.339	11.366	2.043	16.175	2.154
25	...	...	...	...	44.635	1.454	56.256	1.548
60	12.600	4.594	17.199	4.727	11.041	4.153	15.961	4.361
60	...	...	...	...	43.795	2.931	55.700	3.027
100	12.583	8.990	16.767	9.360	10.751	8.321	15.602	8.630
100	...	...	...	...	43.451	6.051	...	...

In aqueous solutions of calcium gluconate at 20°:
(De Carli, 1932)

Gms. per 100 gms. sat. sol.		Solid Phase
(C ₅ H ₆ (OH) ₅ COO) ₂ Ca	As ₂ O ₃	
0.0	1.78	As ₂ O ₃
1.56	2.17	"
2.35	2.25	"
3.22	2.55	"
4.47	3.05	"
9.29	4.97	" + (C ₆ H ₁₁ O ₇) ₂ Ca
7.58	3.45	(C ₆ H ₁₁ O ₇) ₂ Ca
6.57	2.56	"
4.92	1.69	"
4.21	0.96	"
3.45	0.13	"
3.29	0.0	"

SOLUBILITY OF ARSENIC TRIOXIDE IN ORGANIC LIQUIDS

Solvent	t°	Gms. As ₂ O ₃ per 100 gms. sat. sol.	Author
Glycerol	25	15.9	Schmellbach and Rosin, 1929
Diethylmalonate	15	0.058	Zappi and Manini, 1929
	100	0.061	" " "
Ether	15	0.452	Winkler, 1885
Alcohol	15	0.444	"
Carbon Disulfide	15	0.001	"

Freezing point depressions in aqueous solutions containing As₂O₃ + KCl, KBr, KI, NaCl and NH₄Cl were determined by Jozefowicz and Witek, 1955.

As ARSENIC

ARSENIOUS ACID H_3AsO_3 SOLUBILITY OF ARSENIOUS ACID IN AQUEOUS SOLUTIONS
OF POTASSIUM FLUORIDE AT 30°
(Bhagwat and Dhar, 1929)

Mols. KF per liter	0.0	0.08215	0.1643	0.3287
Mols. " "	0.0284	0.2936	0.3026	0.3096

SOLUBILITY OF ARSENIOUS ACID IN GLYCEROL AT 20°
(Holm, 1921, 1922)

Although 20 weeks were allowed for the attainment of equilibrium, agreement between the results obtained by approaching saturation from below and from above was not reached.

Solvent	Gms. Arsenious acid per 100 gms. Glycerol	
	Sat. approached from below	Sat. approached from above
Glycerol of $d = 1.2626$	19.5	25.7
" " $d = 1.2645$	35.4	43.5

EXTRACTION WITH ETHER

The extraction of H_3AsO_3 from NH_4CNS solutions containing HCl and HNO_3 by ether has been studied by Bock, 1951

O ARSENIC PENTOXIDE As_2O_5 SOLUBILITY IN WATER
(Menzies and Potter, 1912)

t°	Gms. As_2O_5 per 100 Gms.	Solid Phase	t°	Gms. As_2O_5 per 100 Gms.	Solid Phase
	Sat. Sol.			Sat. Sol.	
-5	10.6	Ice	-10	36.2	$As_2O_5 \cdot 4H_2O$
-10	15.6		0	37.3	"
-20	21.3	"	+10	38.3	"
-30	25.1	"	20	39.7	"
-40	27.8	"	29.5	41.4	" + $3As_2O_5 \cdot 5H_2O$
-50	29.9	"	40	41.6	$3As_2O_5 \cdot 5H_2O$
-59 (Eutec.)	31.7	Ice + $As_2O_5 \cdot 4H_2O$	60	42.2	"
-50	32.6		80	42.9	"
-40	33.5	"	100	43.3	"
-30	34.4	"	120	43.7	" ..
-20	35.4	"	140	44.5	"

SOLUBILITY IN FORMIC ACID SOLUTION

100 gms. 95% HCOOH dissolve 7.6 gms. As_2O_3 at 19° . (Aschan, 1913.)

ARSENIC ACID $\text{H}_3\text{AsO}_4 \cdot 1/2\text{H}_2\text{O}$

0

SOLUBILITY IN AQUEOUS SOLUTIONS OF SALTS AT 22°
(Dhar, 1926)

An excess of Arsenic acid was shaken with the aqueous solutions for 30 hrs.

Aqueous solution of:	Gm. equiv. of salt per liter	Excess* of Arsenic acid in gm. equiv. per liter	Dissociation constant
Sodium Benzoate $\text{C}_6\text{H}_5\text{COONa}$	0.0283	0.0017	$0.6 \cdot 10^{-6}$
" " "	0.0565	0.0038	$0.3 \cdot 10^{-6}$
" " "	0.1130	0.0062	$0.7 \cdot 10^{-6}$
Sodium Acetate CH_3COONa	0.0475	0.0050	$0.5 \cdot 10^{-6}$
" " "	0.0950	0.0073	$0.1 \cdot 10^{-6}$
" " "	0.1900	0.0015	$0.3 \cdot 10^{-6}$
Sodium Butyrate $\text{C}_3\text{H}_7\text{COONa}$	0.0375	0.0009	$0.3 \cdot 10^{-5}$
" " "	0.0750	0.0030	$0.1 \cdot 10^{-5}$
" " "	0.1500	0.0102	$0.3 \cdot 10^{-6}$

*This probably refers to the excess of arsenic acid above that dissolved by water alone. Although the author mentions that determinations of the solubility in water were made, the results are not given.

EXTRACTION WITH ETHER

The extraction of H_3AsO_4 from NH_4CNS solutions containing HCl by ether has been studied by Bock, 1951.

MetaARSENIC ACID HAsO_3

0

DISTRIBUTION AT 25° BETWEEN:
(Auerbach, 1903)

H_2O and Amyl Alcohol		Sat. Aq. H_3BO_3 Solution and Amyl Alcohol	
Gms. AsO_2H per 1000 cc.		Gms. AsO_2H per 1000 cc.	
Aq. Layer	Alcoholic Layer	Aq. Layer	Alcoholic Layer
4.82	0.90	9.28	1.75
9.63	1.75	18.74	3.47
18.44	3.50		

As ARSENIC

3 ARSENIC TRISULFIDE As_2S_3

1000 cc. water dissolve 0.0008 gm. As_2S_3 at 0°. (Holtje, 1929)
 " " " " 0.00052 gm. As_2S_3 at 18°. (Weigel, 1907)

Fusion point data are given for mixtures of:

$As_2S_3 + Ag_2S$ (Jaeger and Van Klooater, 1912)
 $As_2S_3 + Tl_2S$ (Caunerí-Fernandez, 1925)

5 ARSENIC PENTASULFIDE As_2S_5

SOLUBILITY IN WATER

t°	Gms. As_2S_5 per liter	Author
0°	0.00136	Holtje, 1929*
40°	0.003	Sorum & Wolf, 1950
60°	0.043	" "

*Holtje also gives data for the solubility in water containing H_2S

SOLUBILITY OF As_2S_5 IN HYDROCHLORIC ACID SOLUTIONS (Sorum and Wolf, 1950)

Reprecipitated, washed As_2S_5 was used. Experiments indicated that two hours stirring was sufficient to saturate the solutions in every case. Data are also given for mixtures of $As_2S_5 + Sb_2S_5 + SnS_2$ in HCl.

N = normality of HCl

mg/l = mg. As_2S_5 per liter sat. soln.

HCl N	As_2S_5 mg/l	HCl N	As_2S_5 mg/l	HCl N	As_2S_5 mg/l
At 26°		At 40°		At 60°	
0.0	0.0	0.00	3	0.00	43
1.96	0.0	0.49	2	0.48	37
5.37	0.0	0.86	0	1.00	23
6.50	0.1	1.68	5	2.04	29
7.44	0.6	2.88	0	2.95	29
8.19	1.6	3.63	3	3.70	33
9.07	3.6	4.53	0	4.14	33
9.91	7.3	6.57	8	5.67	45
10.80	20.2	6.48	16	6.52	59
		7.44	27	7.40	85
		8.17	38	8.19	145
		8.98	48	8.99	191
		9.89	93	9.39	218
		10.61	238	10.67	306
		11.35	365		

TRIPHENYLARSINE OXIDE $\text{AsO}(\text{C}_6\text{H}_5)_3$ TRIPHENYLARSINE SULFIDE $\text{AsS}(\text{C}_6\text{H}_5)_3$

Melting points are given for:

$\text{AsS}(\text{C}_6\text{H}_5)_3$	+	Triphenyl phosphine oxide	(Pascal, 1923)
"	+	"	"
"	+	"	sulfide
$\text{AsO}(\text{C}_6\text{H}_5)_3$	+	"	"
"	+	"	"
"	+	"	oxide

GOLD Au

Au

SOLUBILITY OF GOLD IN VARIOUS AQUEOUS SOLUTIONS

The various data are reviewed by Ogryzlo, 1935; Smith, 1943; and Zvyagintsev and Paulson, 1940. Krauskopf (1951) calculated the theoretical solubility in various solutions from free energy data and found them in reasonable agreement with the experimental results. For example, Haber (1928) found the solubility in sea water to be 2×10^{-11} moles per liter; Krauskopf calculates $0.2 - 1 \times 10^{-11}$. The solubility is dependent on the concentration of oxidant and of complexing ion, and the effect of each and of the rate of solution has been studied by McCaughey (1909) and is discussed by Krauskopf. McC. found 0.023 gm. Au/liter after 185 hours in contact with 0.1M Fe^{+++} and 2.4 M Cl^- at about 40° ; K. calculates the theoretical solubility as 0.035 g/l.

SOLUBILITY OF GOLD IN CYANIDE SOLUTIONS

Tronev and Bondin (1937) determined the rate of solubility of powdered gold in potassium cyanide solutions under varying conditions of temperature and pressure. Increased nitrogen pressure over the solution had practically no effect, but the velocity of solution at 18° increased with increased pressures of air up to 50 atmospheres, and then became constant. (In one hour, 100 cc of 1% KCN solution dissolved 41% of a 1 gm. sample of gold.) Under these conditions 225 mg. oxygen were dissolved in 100 cc of solution. At 50° the optimum pressure was not attained. At 50 atm. pressure the rate of solution increased steadily with temperature.

The effect of ozone and oxygen on the solubility of gold in cyanide solutions has been studied by Plaksin and Sinelnikova, 1939.

Plaksin and Shabarin (1940) and Plaksin and Shibaev (1936) give data for the solubilities and the rates of solution of gold-silver and gold-copper alloys in solutions of potassium cyanide of various concentration, alone and in the presence of hydrogen peroxide.

SOLUBILITY OF GOLD IN AQUEOUS SOLUTIONS OF POTASSIUM CYANIDE
(White, 1919)

Rectangular pieces of gold, $1-1/2 \times 1$ cm., were suspended by cotton thread in jars containing 500 cc. of solution. The milligrams of gold dissolved per sq. cm. in 24 hours or less was determined by loss in

Au AURUM

weight. Air was bubbled through the solutions in some cases. It was concluded that the speed of the reaction depends entirely upon the rate of diffusion of the cyanide and the necessary oxygen, of which in practice the latter is the more important. The final effect of the reaction is represented by the well known equation $2 \text{Au} + 4 \text{KCN} + \text{O} + \text{H}_2\text{O} \longrightarrow 2\text{KAu}(\text{CN})_2 + 2 \text{KOH}$. Therefore, 0.010 gm. of oxygen per liter is equivalent to 0.0163 per cent of KCN, 0.007 gm. is equivalent to 0.0114 per cent KCN and 0.006 gm. per liter, to 0.0098 per cent KCN. With water having an average content of 0.006 gm. oxygen per liter the concentration of KCN should not exceed 0.01 per cent.

Au SOLUBILITY OF GOLD AMALGAM IN AQUEOUS SOLUTIONS OF POTASSIUM CYANIDE (White, 1923)

Comparative experiments with two pieces of pure gold, one of which was coated with a very small amount of mercury, suspended in a cyanide solution containing 0.027 per cent KCN and 0.006 per cent NaOH and saturated with oxygen, showed that 1.3 mg. Au per sq. cm. of the pure gold was dissolved in 24 hours at 28°, but that only 0.5 mg. Au per sq. cm. of the amalgam coated gold was dissolved under the same conditions.

Data for the distribution of gold between bismuth and zinc, bismuth and aluminum, lead and zinc, lead and aluminum, and zinc and tellurium, are given by Tammann and Schaftmeister, 1924.

SOLUBILITY OF GOLD IN POTASSIUM CYANIDE SOLUTIONS (Maclaurin, 1893)

Gold disks were placed in Nessler tubes with aqueous KCN solutions.

Per cent KCN	Gms. Au Dissolved in 24 Hours in Nessler Tubes:			
	Full	1/2 Full	Oxygen Passed in	Oxygen + Agitation
0.1	0.00195	0.00331	.....	.....
1	0.00162	0.00418	0.00845	0.0187
5	0.0032	0.0046	0.01355	0.0472
20	0.0012	0.00305	0.0115	0.0314
50	0.00043	0.00026	0.00505	0.0108

The following data for more dilute KCN solutions are given by Christy (1901). Gold strips 2 x 1/4-inch were rotated for 24 hrs. in aq. KCN solutions and the loss in weight determined.

Per cent KCN	Mgs. Au Dissolved	Per cent KCN	Mgs. Au Dissolved	Per cent KCN	Mgs. Au Dissolved
0	0.010	0.002	0.44	0.016	74.96
0.0005	0.043-0.07	0.00325	1.77	0.0325	150.54
0.001	0.10-0.23	0.004	4.29	0.065	168.12
0.0016	0.16	0.008	48.43		

Data are also given for 48-hour periods and for solutions containing O₂.

SOLUBILITY OF GOLD IN THIUREA SOLUTIONS

(Plaksin and Koshchikova, 1941)

100 cc. of each solution was used.

P = Powder G = Granular L = Leaf

Solution Composition	Time in Hours	Mg. Au at Start	Mg. Au in Solution	
0.5% Thiourea	6	10.09 (P)	0.0	
" + 1.0% H ₂ SO ₄	6	10.50 (P)	0.3	
" + 0.06% H ₂ O ₂	6	10.20 (P)	0.32	
" + 1.0% H ₂ SO ₄ + 0.06% H ₂ O ₂	6	10.12 (P)	10.12	Au
" + " + "	48	10.12 (G)	4.53	
" + " + "	48	10.00 (L)	1.60	
0.3% Thiourea + " + "	10	9.80 (L)	0.40	
1.0% Thiourea + " + "	48	9.70 (L)	1.87	
2.0% Thiourea + " + "	48	10.12 (L)	2.80	
0.5% Thiourea + " + "	6	11.18 (L)	0.95	
" + 1.0% HCl + "	6	5.86 (L)	0.60	
" + 1.0% HNO ₃ + "	6	5.48 (L)	0.45	
" + 1.0% NaOH + "	6	11.18 (L)	0.02	
" + 0.1% Ca(OH) ₂ + "	6	10.68 (L)	0.16	
" + 0.5% H ₂ SO ₄ + 0.03% H ₂ O ₂	14	10.23 (G)	4.13	
" + 1.0% H ₂ SO ₄ + "	14	10.12 (G)	4.30	
" + 2.0% H ₂ SO ₄ + "	14	10.22 (G)	4.05	

SOLUBILITY OF GOLD IN MERCURY

(Sunier and Gramke, 1929; Sunier and White, 1930;

Sunier, A.A. and Wainer, 1931; Anderson, 1932; Mees, 1938)

For determinations up to 300° the pyrex glass container for the Hg-Au mixtures consisted of two chambers separated by a capillary and glass wool filter. The mixture after saturation in one of these chambers could be filtered into the other without removing the apparatus from the constant temperature bath. The apparatus was charged with the Hg-Au mixtures of such composition that an insoluble residue of only about 0.5 gm. of Au would remain. It was evacuated, sealed and gently rocked in the water bath for determinations at the lower temperatures, in an oil bath for the intermediate temperatures and in an air bath for the higher temperatures. Equilibrium was approached from above and from below and a period of three hours rocking at the chosen temperature of the determination was allowed. The saturated solution was analyzed by evaporating the Hg from a weighed sample in a current of H (later, air was used at 200°) and then heating the residue of Au to 500-550° for 12-16 hours.

For the determinations between 280° and 400° the synthetic method was used. Since it was necessary to ascertain the temperature at which the last trace of Au just disappeared, there was used a pyrex glass tube provided with two chambers connected at their opposite ends respectively by a capillary tube and a wider tube. When this was properly turned the saturated solution flowed through the capillary and left behind the undissolved Au which could then be seen and the point determined at which the last particle just disappeared.

Au AURUM .

The results of Perravano, 1918 and of Britton and McBain, 1926, which are respectively about 75% and 5% higher than the present results, are discussed. The determinations of Braley and Schneider, 1921 differ so widely from the others that it seems probable that these authors made some serious error. The much older results of Kasaneff are remarkable for their probable accuracy.

t°	Gm. Atoms Au per 100 gm. atoms Au + Hg	t°	Gm. Atoms Au per 100 gm. atoms Au + Hg
0	0.0813	220	3.65
10	0.1038	230	4.17
20	0.1306	240	4.80
30	0.1629	250	5.58
40	0.2014	260	6.55
50	0.2489	270	7.83
60	0.3076	280	9.50
70	0.3767	290	11.80
80	0.4614	300	15.42
80	0.459	307 tr. pt.	18.5
100	0.684	310	23.0
120	0.996	320	27.0
140	1.385	330	29.6
160	1.871	340	32.0
180	2.380	350	34.0
190	2.68	360	35.8
200	2.92	370	37.5
210	3.24	380	39.0
		388	40.0

Analyses of the solid phase in contact with the solutions above the tr. pt. at 307° indicated that it contained approximately 78 atom percent Au.

Br DIETHYL GOLD BROMIDE $(C_2H_5)_2AuBr$

SOLUBILITY IN WATER AND HBr SOLUTIONS AT ROOM TEMPERATURE (Foss and Gibson, 1949)

Normality of HBr	Gms. $(C_2H_5)_2AuBr$ per 100 cc solvent
0	0.012
1	0.104
2	0.174

CH Tetra Ethyl Saccharato di GOLD $(C_2H_5)_2AuO_2C(CHOH)_4CO_2Au(C_2H_5)_2$

The compound is 0.2% soluble in water at room temperature.
(Gibson and Weller, 1941.)

GOLD (ous) CYANIDE AuCN

CN

THE SYSTEM GOLD CYANIDE - POTASSIUM CYANIDE - WATER AT 25°
(Bassett and Corbet, 1924)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
KCN	AuCN		KCN	AuCN	
41.7	0.00	KCN	9.66	2.97	KAu(CN) ₂
42.02	trace	"	7.02	8.34	"
41.98	0.17	" + KAu(CN) ₂	5.19	11.02	"
38.98	0.35	KAu(CN) ₂	4.78	15.47	" + AuCN
24.04	0.76	"	2.60	7.27	AuCN
23.79	0.27	"	2.32	7.32	"
13.70	2.55	"	2.97	6.12	"

GOLD (ous) POTASSIUM CYANIDE AuK(CN)₂

100 gms. glycerol ($d_{15} = 1.256$) dissolve 0.21 gm. AuK(CN)₂·5H₂O at 15-16°. (Ossendowski, 1907.)

GOLD THIOCYANATE Au(SCN)₃

SCN

The extraction of Au(SCN)₃ from NH₄SCN solutions by ether has been studied by Bjerrum and Kirachner, 1918.

GOLD (ic) CHLORIDE AuCl₃

Cl

SOLUBILITY IN WATER

100 gms. H₂O dissolve 68 gms. AuCl₃. (Mylius, 1911.)

DISTRIBUTION OF GOLD CHLORIDE BETWEEN VARIOUS SOLVENTS

Extraction from HCl solution with ethyl ether:
(Mylius, 1911)

When 1 gm. of gold as chloride is dissolved in 100 cc. aq. HCl of different strengths and the solutions shaken with 100 cc. portions of ether, the following percentages of the gold enter the ethereal layer. With 20% HCl, 95%; 10% HCl, 98%; 5% HCl, 98%; 11% HCl, 84% and 0.18% HCl, 40.3% of the gold.

Distribution results, indicating considerable variation in the constitution of the dissolved substance in the two layers, are also given.

Au AURUM

Extraction from HBr solution with ethyl ether, isopropyl ether and ethyl acetate at about 25°:

(McBryde and Yoe, 1948)

Gold solutions (as chloride) containing 1.0, 0.1 and 0.01 mg Au per ml with various concentrations of HBr were shaken with an equal volume of organic solvent. Some similar data with HCl are also given.

Solvent	approx. molarity HBr	% gold extracted		
		1.0 mg/ml	0.1 mg/ml	0.01 mg/ml
Isopropyl ether	0	45	...	...
	0.8	78	96	78
	1.5	90.9	99	95
	2.0	94.0	100	98
	2.9	97.1	99	100
Ethyl ether	4.0	97.6	89	...
	2.0	98.0	100	95
	2.5	98.6	...	...
	2.9	98.5	100	94
Ethyl acetate	0*	98.4	93	...
	1.5	98.7	100	98
	2.5	99.2	100	98
	4.2	94.7	...	...
Hexone	0*	..	100	...
	2.0	99.8	100	100
	3.6	..	100	...

*1 gm. solid KBr added

CI GOLD ALKALI DOUBLE CHLORIDES $AuMCl_4$

SOLUBILITY OF SODIUM GOLD CHLORIDE, LITHIUM GOLD CHLORIDE, POTASSIUM GOLD CHLORIDE, RUBIDIUM GOLD CHLORIDE, AND CESIUM GOLD CHLORIDE IN WATER
(Rosenblatt, 1886)

t°	Grams Anhydrous Salt per 100 Grams Solution				
	NaAuCl ₄	LiAuCl ₄	KAuCl ₄	RhAuCl ₄	CsAuCl ₄
10	58.2	53.1	27.7	4.6	0.5
20	60.2	57.7	38.2	9.0	0.8
30	64.0	62.5	48.7	13.4	1.7
40	69.4	67.3	59.2	17.7	3.2
50	77.5	72.0	70.0	22.2	5.4
60	90.0	76.4	80.2	26.6	8.2
70	..	81.0	..	31.0	12.0
80	..	85.7	..	35.3	16.3
90	..	..	..	39.7	21.7
100	..	..	..	44.2	27.5

GOLD PHOSPHORUS Tri CHLORIDE (Aurous) $\text{AuCl}_2\text{PCl}_2$

100 gms. PCl_3 dissolve 1 gram at 15° , and about 12.5 grams at 120° . (Lindet, 1885).

GOLD (Ic) IODIDE AuI_3

I

AuI_3 is practically completely extracted by ether from 6.9N HCl.

GOLD Ammonium NITRATE $\text{Au}(\text{NH}_3)_4(\text{NO}_3)_3$

NO

SOLUBILITY IN WATER AND KNO_3 SOLUTION AT 25°
(Weitz, 1914)

Gms. $\text{Au}(\text{NH}_3)_4(\text{NO}_3)_3$
per 100 gms. sat. sol.

Water.....	2.88
Aq. 0.1 \underline{n} KNO_3	2.156

GOLD HYDROXIDE (Auric) $\text{Au}(\text{OH})_3$

OH

The solubility of auric hydroxide in water, as calculated from satisfactorily agreeing values for the solubility product, assuming complete dissociation, is 2.4×10^{-12} mols. $\text{Au}(\text{OH})_3$ per liter. (Jirsa and Jenuek, 1924.)

SOLUBILITY OF AURIC HYDROXIDE IN AQUEOUS SOLUTIONS OF SULFURIC
ACID AT 11°

(Jirsa and Buryanek, 1923; Jirsa and Jelinek, 1924)

Gold hydroxide, $\text{Au}(\text{OH})_3$, prepared by anodic oxidation of gold was agitated in a thermostat at 11° with aqueous H_2SO_4 solutions for different lengths of time. The curves show an increase with time. The freshly made hydroxide dissolves more rapidly than older hydroxide. It is not certain that equilibrium was reached. In the later experiments an attempt was made to approach equilibrium from above, that is, to go from concentrated solutions, by hydrolysis, to dilute solutions. It appears that a tendency exists to form supersaturated solutions in the beginning, but in about 48 hours a concentration is reached which agrees fairly well with that found previously by constant agitation for 60 days. The results for diluted 35 normal H_2SO_4 solutions rotated 60 days with the original solid phase and with new, were:

Normality of H_2SO_4	11.72	12.56	19.33
Gms. Au per 100 cc. solution.....	0.0922	0.1324	1.4128

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THE SOLUBILITY OF GOLD HYDROXIDE IN AQUEOUS SOLUTIONS OF
SODIUM HYDROXIDE AT 25°
(Johnston and Leland, 1938)

Gm. Mols. per 1000 gms. H ₂ O		Solid Phase	Gm. Mols. per 1000 gms. H ₂ O		Solid Phase
NaOH	Aux10 ⁻⁴		NaOH	Aux10 ⁻⁴	
0.0	0.031	Au(OH) ₃	0.522	7.26	Na ₂ HAuO ₃
0.0752	0.87	"	0.667	4.69	"
0.1005	1.00	"	0.748	3.50	"
0.1507	2.00	"	0.840	2.62	"
0.1998	2.91	"	1.049	1.50	"
0.2997	5.64	"	1.682	1.70	"
0.3900	9.73	"	3.095	2.35	"
0.4138	10.54	"	3.983	2.69	"
0.4215	9.79	Na ₂ HAuO ₃	6.05	3.84	"
0.4941	7.73	"	8.37	5.23	"

The authors also give results for the solubility of gold hydroxide in aqueous 0.2 normal sodium hydroxide containing increasing amounts of potassium sulfate.

50 GOLD BARIUM THIOSULFATE $Au_2S_2O_3 \cdot 3BaS_2O_3$

4.58 gms. $Ba_3[Au(S_2O_3)_2]_2 \cdot 6H_2O$ dissolve in 100 ml of H₂O. (Jane, 1950.)

AIR (See also data for Nitrogen and Oxygen gases)

SOLUBILITY OF AIR IN WATER

Determinations of the solubility of air in water have been made by Bunsen (1855), Dittmar (1884), Winkler, (1901, 1904, 1921) and Rakestraw and Emmel (1937). Bunsen's values are 15-20% smaller, and Dittmar's values 2-5% larger than the results given below, which are those of Winkler (1904, 1921) up to 30°. Winkler's earlier values (1901) differ slightly from these. Above 30°, Winkler's 1901 data are given.

β = ml. gas (measured at 0°, 1 atm) dissolved in 1 ml. of liquid when the partial pressure of the gas is 1 atm.

t°	β	Volume % O ₂ in dissolved gas	t°	β	Volume % O ₂ in dissolved gas
0	0.02918	34.91	25	0.01708	33.82
5	.02568	34.69	30	.01564	33.60
10	.02284	34.47	40	.01418	-
15	.02055	34.25	50	.01297	-
20	.01868	34.03	60	.01216	-
22	.01801	33.95	80	.01126	-
22	.0179 (R.&E.)	-	100	.01105	-

SOLUBILITY OF AIR IN SULFURIC ACID SOLUTIONS AT 21°

(Bohr, 1910; Tower, 1906; Christoff, 1906)

The data below are those of Bohr. Tower's data at 20° are similar but less consistent. Those of Christoff at 18° are somewhat higher.

The results are in cc of air (measured at 0°, 760mm) dissolved in 1 cc of solution when the partial pressure of air is 1 ata.

t°	Normality of H ₂ SO ₄	cc H ₂	cc O ₂	β Total
20.9	0.0	0.0125	0.0062	0.0187
20.9	4.9	.0073	.0039	.0112
20.9	8.9	.0058	.0031	.0089
21.2	10.7	.0053	.0029	.0082
21.1	30.2	.0039	.0024	.0063
21.5	24.8	.0038	.0021	.0059
20.8	29.6	.0041	.0023	.0064
20.9	34.3	.0080	.0040	.0120
21.1	35.8	.0103	.0055	.0158

SOLUBILITY OF AIR - CARBON DIOXIDE MIXTURES IN SOLUTIONS

CONTAINING H₂SO₄ + Na₂SO₄ AT 25°

(Kobe and Kanton, 1938)

Note: The authors determined the solubility of a number of gases in a solution of Sodium Sulfate + Sulfuric Acid which was made up from 200 gms Anhydrous Sodium Sulfate + 800 grams of water + 40 ml of 36N (conc.) H₂SO₄. They suggest the use of the solution as a confining liquid in gas analyses. The aqueous tension of the solution was determined, and may be represented by:

$$\log P = 0.2675 - \frac{2375}{T}$$

Where P is the vapor pressure in millimeters of mercury, and T is the absolute temperature.

Gas Dissolved	α	β
Air	0.0053	0.0049
Air + 5% CO ₂	.0135	.0124
Air + 10% CO ₂	.0235	.0215
79.4% N ₂ + 6.1% O ₂ + 14.5% CO ₂	.0310	.0284
Air + 20% CO ₂	.0447	.0410
CO ₂	.270	.247

AIR

SOLUBILITY OF AIR IN AMMONIUM CHLORIDE SOLUTIONS (Coste and Andrews, 1924)

The earlier work of MacArthur, 1916 was shown to be incorrect.

Moles NH_4Cl per liter	t°	cc dissolved gases per liter	
		Nitrogen + Argon	Oxygen
0.5	20	10.65	5.48
1.0	20	10.29	5.08
1.0	19	10.15	5.70
2.0	27	7.79	3.93

SOLUBILITY OF AIR IN BRINE AT HIGH PRESSURE (Eichelberger, 1955)

The following equations describe the solubility from pure water to saturated brine.

t°	Pressure Range, P.S.I.	
25	1000-3500	$\log \beta = 0.8067 \log P - 0.00243 C - 2.3708$
45	1000-3500	$\log \beta = 0.8241 \log P - 0.00215 C - 2.5130$
55	2500-3500	$\log \beta = 0.7705 \log P - 0.00208 C - 2.3580$
65	1000-3500	$\log \beta = 0.8453 \log P - 0.0202 C - 2.6318$

where β = ml of air measured at S.T.P. per ml of brine

P = pounds per square inch (gage)

C = gms NaCl per liter (at 1 atm)

SOLUBILITY OF AIR IN SEA WATER

Fox (1909) gives equations for the solubility of oxygen and nitrogen in sea water with varying temperatures ($0^\circ - 28^\circ$) and Cl content (0 - 20 parts of Cl per 1000 parts H_2O).

Dittmar (1884) studied the composition of ocean waters throughout the world, at the surface and at various depths. He reports the average solubility of air in sea water to be as follows:

Temp.	β	Vol. % O_2 in Dissolved Gas
0°	0.02378	34.40
5°	.02108	34.24
10°	.01892	34.09
15°	.01717	33.93
20°	.01572	33.78
25°	.01449	33.62
30°	.01344	33.47
35°	.01253	33.31

Extensive data upon the rate of solution of atmospheric nitrogen and oxygen in water are given in a series of papers by Adeney and Becker, 1916-1920, 1919, 1920 and 1921. One of the methods of experimenting consisted in inclosing a large bubble of air, of known volume, in a narrow tube containing deaerated water, and allowing the bubble to pass up through the water repeatedly until saturation was reached. From the figures given it is possible to calculate the rate of solution for any condition of area exposed, depth, or degree of saturation.

SOLUBILITY OF AIR IN LIQUID CHLORINE AT 1-7 ATM. PRESSURE
(Rössler and Hasselacher, 1928)

Temp:	-30°	-2°	+30°
β	0.30	0.32	0.37

SOLUBILITY OF AIR IN ORGANIC SOLVENTS

(Mostly Kretschmer, Nowakowska and Wiebe, 1946, also:

Robinet, 1864; Parmelee, 1951; Angstrom, 1888; Christoff, 1912; Dolezalek, 1910; Brameld and Clark, 1946; Jenkins and Shorthose, 1928)

Results are given in terms of the Ostwald coefficient (l) which is the ml of air (measured at 1 atm and the temperature of the experiment) dissolved in 1 ml of solvent when the partial pressure of air is 1 atm.

Solvent	t°	l	Solvent	t°	l
Acetone	-25	0.1570	Ethanol (95%)	-25	0.1137
	0	.1777	(by vol.)	0	.1232
	25	.2031		25	.1326
Data of Brameld and Clark in			Room		.141(R.)
mg. of Air per gram of acetone:			50		.1450
	0	0.0222	{ Ethanol 50%	0	.1643
	5	.0200	{ Acetone 50%	25	.1816
	10	.0177	{ (by vol.)	50	.2028
	15	.0154	{ Ethanol 50%	0	.2077
	20	.0130	{ i-Octane 50%	25	.2208
	30	.00829	{ (by vol.)	50	.2347
	35	.00582	Ethyl chloride	11	~.07 (J.&S.)
	40	.00336	Ethyl ether	0	.290 (C.)
Benzene	Room	.140(R.)		10	.287 (C.)
(See also A., D.,)				15	.286 (C.)
n-Butanol	0	.1296			(See also A.)
	25	.1417	Freons		see following table
	50	.1536	Methanol	-25	.1652
Chloroform (See A.)				0	.1733
Ethanol	-25	.1523		25	.1827
(abs.)	0	.1615		50	.1937
	25	.1692			(See also A.)
	50	.1798	Nitroethane		(See A.)
(See also A.)			iso-Octane	-25	.2367
				0	.2442
				25	.2580
				50	.2762
			iso-Propanol	0	.1592
				25	.1684
				50	.1822

AIR

SOLUBILITY OF AIR IN FREONS (Parmelee, 1951)

The solubility follows the Henry's law equation $X = kp$

where X = mole fraction of air in solution

p = partial pressure of air in p.s.i. (absolute)

Temp. °F	values for k	
	Freon 12	Freon 22
75.2	1.5×10^{-4}	1.4×10^{-4}
0.0	3.5×10^{-4}	3.9×10^{-4}
-40.0	7.0×10^{-4}	7.4×10^{-4}

The solubility varies with temperature according to the equations:

$$\text{Freon 12} \quad \log K = \frac{1320}{T} - 6.30$$

$$\text{Freon 22} \quad \log K_2 = \frac{1390}{T} - 6.45$$

Where T is given in Rankine degrees. The effect of total pressure upon the solubility was also determined.

SOLUBILITY OF AIR IN FATS AND OILS

(Schaffer and Haller, 1943; Schmidt-Nielsen, 1927; Van Slyke, 1939; Robinet, 1864; Burrows and Preece, 1953)

See also Vernon, 1907; Derry, et al., 1952.

β = cc of air (measured at 0°, 760 mm) dissolved in 1 cc of oil.

β' = cc of air (measured at 0°, 760 mm) dissolved in 1 gm. of oil.

Oil or Fat		Temp. °	β	β'	Vol. % O ₂ in dis- solved gas
S.&H.	Butter Oil	40	1.01	---	---
	"	60	0.96	---	---
	Lard	40	0.88	---	---
VS.	Cottonseed Oil	40	0.87	---	---
	Olive Oil	19	0.0759	---	---
	"	20	---	0.50	28.7
	"	50	---	0.61	15.7
	Cottonseed Oil	20	---	0.50	32.4
	"	50	---	0.64	16.2
	Linseed Oil	20	---	1.01	19.1
	"	50	---	1.04	10.0
SN.	Corn Oil	20	---	0.47	29.6
	"	50	---	0.64	11.6
	Mineral (Transformer) Oil	20	---	0.84	30.6
	"	50	---	0.81	30.5
	Cod Liver Oil	20	---	0.96	21.8
	"	---	---	0.90	23.8
	Herring Oil	20	---	0.59	---
	"	50	---	0.57	---

	Oil or Fat	Temp.	β	β'	Vol. % O ₂ in dis- solved gas
R.	Petroleum	Room	.068	---	---
	Oil of Lavender	Room	.069	---	---
	Oil of Turpentine	Room	.242	---	---
B.&P.	Kerosene	-17.8(0°F)	.140	---	---
	"	18.3(65°F)	.134	---	---
	"	42.3(108°F)	.134	---	---

The solubility of air in blood was determined by Van Slyke and Neil, 1924.

BORON B

No compounds are found in the system Boron + Boron Tribromide.
(Cueilleron, 1944.)

The following systems have been studied by x-ray methods:
B + Mn (Kiessling, 1950), B + B₄C (Allen, 1953), B + Ti (Ebrlich, 1949;
Anderson and Kiessling, 1950).

Less than 0.001% B dissolve in austenite steel at normal heat treatment temperatures. (Busby, Wurga, and Wells, 1953.)

BORON Tri BROMIDE BBr₃

Br

FUSION POINTS IN THE SYSTEM BORON TRIBROMIDE - BROMINE
(Cueilleron, 1944)
(Selected Data)

Temp.	Gms. BBr ₃ per 100 gms. mixture	Solid Phase	Temp.	Gms. BBr ₃ per 100 gms. mixture	Solid Phase
-5.7	0.0	Br ₂	-60.1	80.0	Br ₂ + BBr ₃
-17.1	25.0	"	-53.0	91.0	BBr ₃
-38.9	60.5	"	-47.5	100.0	"

Data for the systems BBr₃ + AlBr₃, AsBr₃, SnBr₄ and SnI₄ may be found on pp. 161, 229 and under SnBr₄ and SnI₄ respectively. (Adamsky and Wheeler, Jr., 1954.)

BORON Tri CYANIDE B(CN)₃

CN

The solubility of B(CN)₃ in benzene, ethyl ether, chloroform, carbon tetrachloride and carbon disulfide is about 3-4%. In BCl₃ it is about 4% (all at "ordinary" temperature). (Chaigneau, 1954.)

B BORON

CI BORON TRI CHLORIDE BCl_3

FUSION POINTS OF MIXTURES OF BORON TRICHLORIDE + CHLORINE AND OF BORON TRICHLORIDE + HYDROGEN CHLORIDE (Graff, 1933; Hackspill, 1933)

Results for BCl_3 + Cl_2			Results for BCl_3 + HCl		
t°	Gms. BCl_3 per 100 gms. of mixture		t°	Gms. BCl_3 per 100 gms. of mixture	
-103.0	0.0		-115.0	0.0	
-135.4 (Eutec)	65.5		-134.0 (Eutec)	44.0	
-108.7	100.0		-108.7	100.0	

A vapor pressure study of the system BCl_3 + HF_3 at -103° showed that two partially miscible liquid phases are formed containing about 25 and 75 mole % BCl_3 . (Cooke and Mackenzie, 1953.)

FREEZING POINTS IN THE SYSTEM BORON TRICHLORIDE - SULFUR DIOXIDE (Martin, 1945)

Mol. % BCl_3	Freezing Points*		Mol. % BCl_3	Freezing Points	
	BCl_3 in SO_2	SO_2 in BCl_3		BCl_3 in SO_2	SO_2 in BCl_3
0.0	-76.0	---	49.3	-78.0	---
2.1	-76.8	---	59.8	-78.2	-107.3
3.8	-77.1	---	70.5	-78.0	-106.7
9.9	-78.0	---	79.7	-78.1	-108.3
19.8	-78.0	---	93.8	-78.2	---
29.6	-78.0	---	100.0	---	-108.3
40.1	-78.1	-108.1			

FREEZING POINTS IN THE SYSTEM BORON TRICHLORIDE - PHOSGENE (Martin and Faust, 1949) (Selected Data)

Mole % BCl_3	Temp.	Solid Phase	Mole % BCl_3	Temp.	Solid Phase
0.0	-132.5°	COCl_2	45.8	-128.0°	BCl_3
12.2	-135.0°	"	75.3	-115.0°	"
25.6	-142.3°	COCl_2 + BCl_3	100.0	-107.3°	"

FREEZING POINTS IN THE SYSTEM BORON TRICHLORIDE - HYDROGEN SULFIDE
(Martin, 1945)

This system is similar to the system $\text{BF}_3 - \text{H}_2\text{S}$. It contains A 1:1 compound whose melting point is -35.3° and is stable over a large range of concentrations. The curve is quite flat at the maximum.

(Selected Data)

Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase	Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase
0.0	-85.4	H_2S	50.0	-35.3	$\text{BCl}_3\text{-H}_2\text{S}$
2.0	-93.9	$\text{H}_2\text{S} + \text{BCl}_3\text{-H}_2\text{S}$	80.0	-44.4	"
9.7	-48.1	$\text{BCl}_3\text{-H}_2\text{S}$	99.9	-108.8	$\text{BCl}_3\text{-H}_2\text{S} + \text{BCl}_3$
25.2	-41.2	"	100.0	-107.9	BCl_3

FREEZING POINTS IN THE SYSTEMS BORON TRICHLORIDE - METHYL CHLORIDE
AND BORON TRICHLORIDE - ETHYL CHLORIDE

(Martin and Hicks, 1946)

(Selected Data)

With Methyl Chloride			With Ethyl Chloride		
Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase	Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase
0.0	-97.1	CH_3Cl	0.0	-138.2	$\text{C}_2\text{H}_5\text{Cl}\cdot 2\text{BCl}_3$
29.8	-112.5	"	14.3	-143.9	$\text{C}_2\text{H}_5\text{Cl} + \text{C}_2\text{H}_5\text{Cl}$
51.8	-125.1	$\text{CH}_3\text{Cl} + \text{BCl}_3$	40.0	-121.2	$\text{C}_2\text{H}_5\text{Cl}\cdot 2\text{BCl}_3$
75.5	-115.0	BCl_3	55.0	-116.6	"
100.0	-107.6	"	66.7	-115.8	" + BCl_3
			72.8	-116.3	$\text{C}_2\text{H}_5\text{Cl}\cdot 2\text{BCl}_3$
			100.0	-107.2	BCl_3

FREEZING POINTS IN THE SYSTEMS BORON TRICHLORIDE - PROPYL CHLORIDE
AND BORON TRICHLORIDE - ISOPROPYL CHLORIDE

(Martin and Humphry, 1947)

(Selected Data)

With Propyl Chloride			With Isopropyl Chloride		
Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase	Mol. % BCl_3	Temp. $^\circ\text{C}$	Solid Phase
0.0	-122.3	$\text{C}_3\text{H}_7\text{Cl}$	0.0	-117.7	1 - $\text{C}_3\text{H}_7\text{Cl}$
25.1	-131.9	"	6.4	-118.5	1 - $\text{C}_3\text{H}_7\text{Cl} + 3:1$
42.4	-141.8	$\text{C}_3\text{H}_7\text{Cl} + \text{BCl}_3$	19.7	-107.3	3:1
64.5	-120.5	BCl_3	25.0	-105.0	"
100.0	-107.0	"	34.6	-106.0	"
			59.6	-111.9	"
			70.7	-114.7	3:1 + BCl_3
			89.9	-109.4	BCl_3
			100.0	-107.2	"

3:1 = $(1 - \text{C}_3\text{H}_7\text{Cl})_3\text{-BCl}_3$

B BORON

F BORON TRI FLUORIDE BF_3

SOLUBILITY IN WATER AND CONC. H_2SO_4

1 cc. H_2O absorbs 1.057 cc. BF_3 at 0° and 762 mm.; 1 cc. conc. H_2SO_4 (Sp. Gr. 1.85) absorbs 50 cc. BF_3 .

SOLUBILITY OF BF_3 IN n-PENTANE (Cade, Dunn, and Hepp, 1946)

Values read from curves given by the authors. Solubilities are expressed in cc of BF_3 (at 0°C , 1 atm pressure BF_3) per gram of normal Pentane. At constant partial pressure of BF_3 , the solubility in n-Pentane is a minimum at about 70° .

Total Pressures in atmospheres	49°	66°	93°
4.0	1.6	0.8	---
6.0	3.4	2.3	0.6
8.0	5.0	3.7	2.1
10.0	6.7	5.3	3.8
12.0	8.9	7.0	5.8
14.0	11.7	9.0	---

SOLUBILITY OF BF_3 IN BENZENE AND TOLUENE (Wheeler, Jr. and Keating, 1954)

l = Ostwald coefficient = ml BF_3 measured at 1 atm. at the temperature of the experiment dissolved in 1 ml of solvent (also measured at the temperature of the experiment).

x = mole fraction of BF_3 in solution at a partial pressure of BF_3 of 1 atm.

t°	In benzene l	x	t°	In toluene l	x
22.2	0.670	0.00247	27.2	0.630	0.00279
27.2	.662	.00242	31.2	.625	.00274
32.2	.658	.00239	37.2	.618	.00268
37.2	.650	.00236	39.2	.615	.00266
42.2	.645	.00229	43.2	.611	.00261
47.2	.636	.00226	49.2	.603	.00254

SOLUBILITY OF BF_3 IN ANHYDROUS HF AT 19° (McCauley and Lien, 1951 (0°); Kilpatrick and Luborsky, 1954 (19°))

(Read from graphs)

at 0°		at 19°	
Total pressure atmospheres	Moles BF_3 per 1000 gms. HF	Total pressure atmospheres	Moles BF_3 per 1000 gms. HF
0.48	0.0	1.0	0.0
0.75	0.19	2.0	0.14
1.0	0.35	3.0	0.30
1.25	0.50	4.0	0.46
1.5	0.64	5.0	0.62
2.0	0.90	6.0	0.80

F

THE SYSTEM BORON TRIFLUORIDE - BROMINE

(Fischer, Steunenberg & Vogel, 1954)

Solid-Liquid data			Selected data for the two liquid region		
t°	mole % Br_2 in sat. sol.	Solid Phase	t°	mole % Br_2	
				Upper Phase	Lower Phase
8.77	0.0	BF_3	9.0	13.9	95.4
7.4	2.58	"	16.1	16.2	94.8
6.2	5.36	"	25.0	17.7	92.9
4.9	9.80	"	31.0	20.6	91.1
3.6	13.9	$\text{BF}_3 + 2$ liquids	35.3	22.2	90.0
-3.7	97.65	BF_3	45.8	29.7	84.8
-8.8	98	$\text{BF}_3 + \text{Br}_2$	47.6	32.2	82.8
-8.0	99.20	Br_2	49.5	34.2	82.7
-7.2	100	"	55.5	61	(Consolute Point)

FREEZING POINTS IN SYSTEMS OF BORON TRIFLUORIDE

(Booth and Martin, 1942)

(Selected Data)

With Methyl Chloride			With Hydrogen Chloride		
Mol. % BF_3	Temp. °C	Solid Phase	Mol. % BF_3	Temp. °C	Solid Phase
0.0	-96.7	CH_3Cl	0.0	-113.1	HCl
41.2	-116.8	"	9.8	-120.2	"
65.5	-144.8	$\text{CH}_3\text{Cl} + \text{BF}_3$	20.3	-124.1	"
83.3	-134.0	BF_3	37.8	-126.9	"
100.0	-126.7	"	60.0	-141.2	"
			72.3	-134.2	$\text{HCl} + \text{BF}_3$
			89.7	-130.5	BF_3
			100.0	-127.0	"

(Cont.)

9 BORON

With Nitrous Oxide			With Sulfur Dioxide		
Mol. % BF ₃	Temp. °C	Solid Phase	Mol. % BF ₃	Temp. °C	Solid Phase
0.0	-91.1	N ₂ O	0.0	-73.5	SO ₂
40.0	-109.8	"	22.3	-84.7	"
76.6	-138.0	N ₂ O + BF ₃	38.0	-97.2	SO ₂ + SO ₂ ·BF ₃
87.1	-132.3	BF ₃	50.0	-96.0	SO ₂ ·BF ₃
100.0	-126.8	"	79.8	-106.8	"
			95.2	-128.6	SO ₂ ·BF ₃ + BF ₃
			100.0	-126.8	BF ₃

Booth and Walkup, 1943 report the freezing points of the following F mixtures:

BF ₃ + CF ₂ Cl ₂	(Practically completely immiscible)
BF ₃ + CF ₃ Cl	(Partially miscible at freezing points, liquids miscible at higher temperatures)
BF ₃ + CF ₄	(Partially miscible at freezing points, liquids miscible at boiling points)
BF ₃ + PF ₃	(Eutectic at 21.5 mol. %, -163.5°, no evidence of compound formation)
BF ₃ + POF ₃	(Evidence is found for the compound F ₃ PO·BF ₃ , M.P. about -20°)
BF ₃ + PSF ₃	(Eutectic at 16.0 mol. %, -151.2°, no compounds formed)
BF ₃ + SOF ₂	(1:1 compound is formed, M.P. -140.8°)

FREEZING POINTS IN THE SYSTEM BORON TRIFLUORIDE - PHOSGENE (Martin and Faust, 1949) (Selected Data)

Mol. % BF ₃	Temp.°	Solid Phase	Mol. % BF ₃	Temp.°	Solid Phase
0.0	-132.5	COCl ₂	50.0	-134.3	1:1 (F.P.)
15.3	-138.0	"	60.4	-142.3	1:1 + BF ₃
23.2	-143.0	COCl ₂ + 2:1	80.7	-133.0	BF ₃
33.3	-137.0	2:1 (F.P.)	100.0	-127.6	"
38.4	-138.0	2:1 + 1:1			

2:1 = 2COCl₂·BF₃, 1:1 = COCl₂·BF₃, F.P. = Freezing point of compound.

THE SYSTEM BF₃ - H₂S (Germann and Booth, 1926)

The system was found to contain two eutectics, a maximum corresponding to BF₃·H₂S with f. pt. -137° and a transition point of a compound BF₃·7H₂S at -99°. Judging from the flatness of the curve at the maximum, the compound BF₃·H₂S is considerably dissociated, so that there should be little difficulty separating H₂S as an impurity from BF₃ by fractional distillation.

Data for the systems BF₃ + AsH₃ and BF₃ + HBr, and partial data for the system BF₃ + PH₃ are given by Martin and Dial, 1950. In the AsH₃ and HBr systems miscibility gaps occur between about 10 and 80 mole % BF₃. The eutectics lie at about -130°. Compound formation is indicated with PH₃.

The systems $\text{BF}_3 + \text{A}$, $\text{BF}_3 + \text{Kr}$, and $\text{BF}_3 + \text{Xe}$ were examined by Wiberg and Karbe, 1948. No compounds are formed.

A few melting points in the system $\text{BF}_3 + \text{HNO}_3$ indicate the presence of the compound $\text{HNO}_3 \cdot 2\text{HF}_3$, m.p. 53° . (Gerding, Heertjls, Revallier and Steeman, 1952.)

DIBORANE B_2H_6

H

SOLUBILITY OF DIBORANE IN ETHYL ETHER AND TETRAHYDROFURAN (Elliott, Roth, Roedel and Boldebeck, 1952)

Results at 1 atm. partial pressure of B_2H_6

In ethyl ether		In tetrahydrofuran	
t°	Gms. B_2H_6 per 100 Gms. ethyl ether	t°	Gms. B_2H_6 per 100 Gms. Tetrahydrofuran
0°	1.6	7	11.6
10°	1.4	20	8.0
20°	1.1	30	6.1
30°	1.0	40	4.7
40°	0.89	50	3.9
50°	0.75		

Melting points in the system diborane-tetrahydrofuran are given by Rice, Livasy and Schaeffer, 1955.

SOLUBILITY OF DIBORANE IN n-PENTANE (McCarty and Guyon, 1954)

S = mole % B_2H_6 in solution when the partial pressure of B_2H_6 is 1 atm.

t°	0.0	10.2	19.6	30.7	39.0	54.8
S	3.4	3.0	2.6	2.2	1.9	1.6

BORON OXIDE, BORIC ANHYDRIDE B_2O_3

O

The water solubility of various glasses made by introducing B_2O_3 into melts of Na_2O , $\text{CaO} - \text{ZrO}_2 - \text{SiO}_2$ was studied at 100° , 1 atm. and $172-251^\circ$, 8-40 atm. by Nagai and Kawamura, 1951.

BORIC ACID H_3BO_3

OH

SOLUBILITY OF BORIC ACID IN WATER

The data of Blasdale and Slansky (1939) and Nasini and Ageno (1909) are in very good agreement from $0^\circ-90^\circ$. Determinations by Kendall and Andrews, 1921; Linderstrom and Lang, 1924; Kolthoff, 1926; Menzel, 1927; Levi and Gilbert, 1927; Herz and Knoch, 1904; Auerbach, 1903; Sborgi and Amelotti, 1930; and Sborgi, 1932; Levi and Aguzzi, 1938; Carpeni, 1955

are in satisfactory agreement with these results. The work of Ditte (1877) and Burgess and Hunter (1929), are not in good agreement. The data above 100° are those of Benrath (1942), which are approximately the same as those given in graphical form by von Stackelberg, Quantram and Dressel (1937), and McCulloch (1937) for the system $B_2O_3 - H_2O$ (see below). The data of Nasini and Ageno at 100°, 110° and 120° seem considerably too high.

Data in table:

-0.76° (eutectic) Nasini and Ageno, 1909; 0°-103.3° (boiling point) Blasdale and Slansky, 1939; 110°-181°, Benrath, 1942.

0	t°	Gms. H ₃ BO ₃	t°	Gms. H ₃ BO ₃	t°	Gms. H ₃ BO ₃
		per 100 gms. sat. sol.		per 100 gms. sat. sol.		per 100 gms. sat. sol.
	-0.76(Eutec.)	2.46	55	11.54	120	35.2
	0	2.70	60	12.96	126	39.2
	5	3.14	65	14.42	138	45.7
	10	3.52	70	15.75	141	47.9
	15	4.17	75	17.40	145	49.4
	20	4.65	80	19.06	152	56.5
	25	5.43	85	21.01	160	63.4
	30	6.34	90	23.27	166	70.6
	35	7.19	95	25.22	172	77.6
	40	8.17	100	27.53	176	85.0
	45	9.32	103.3(b.pt.)	31.0	181	100.0(m.pt., incongruent)
	50	10.23				

The System $B_2O_3 - H_2O$

Data read from the diagram of McCulloch (1937), see also von Stackelberg, Quantram and Dressel (1937).

McCulloch obtained crystalline B_2O_3 by fusing boric acid under atmospheric pressure at 225-250°. The liquid thus obtained becomes cloudy after several days and finally thickens, becomes pasty and at last reaches a state of stone like hardness. Its density is 2.42 instead of only 1.84 which is the density of boric oxide glass. The solubility determinations at temperatures above 215° were made by heating 25 gm. portions of crystalline B_2O_3 with small amounts of H_3BO_3 in sealed pyrex tubes at the given temperatures until equilibrium was reached, draining the liquid from the solid by tilting the tube, solidifying the liquid by rapid cooling, and analyzing the solid thus obtained.

t°	Gms. B_2O_3 per 100 gms. sat. sol.	Solid Phase
103.2(b. pt. sat. sol.)	17.5	H_3BO_3
170.0(m. pt.)	56.	"
168 (tr. pt.)	61.	" + HBO_2
203 (m. pt.)	80.	HBO_2
215-220	80.1	B_2O_3 (cryst.)
245-250	82.8	"
310-315	85.0	"
460-470(m. pt.)	96.6	"

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 18°

(Kolthoff, 1926; Linderstrom-Lang, 1924 (at 17.85°))

moles HCl per liter of solvent	moles H ₃ BO ₃ per liter sat. sol.	moles HCl per liter solvent	moles H ₃ BO ₃ per liter sat. sol.
0.0	0.736 (0.722 L.&L.)	1.0	0.595
0.5	0.655	1.2	0.5778
0.6	0.6435	1.5	0.5463

Results at 25°

(Kendall and Andrews, 1921)

0

The authors point out that the data of Herz (1903, 1910), which become increasingly lower above 3M HCl than the values below, are probably in error because the analyses were made for "total acid" before and after saturation with H₃BO₃, but no correction for the change in volume of the solution was applied. Hence a small total error is reflected in a large error in % H₃BO₃, the lesser component.

moles per liter sat. sol.		moles per liter sat. sol.		moles per liter sat. sol.	
HCl	H ₃ BO ₃	HCl	H ₃ BO ₃	HCl	H ₃ BO ₃
0.0	0.8950	1.147	0.7042	5.460	0.3715
0.0660	0.8810	1.802	0.6270	7.073	0.3445
0.1302	0.8580	2.617	0.5431	9.380	0.3501
0.2733	0.8380	3.126	0.4976	11.56	0.3687
0.6112	0.7761	4.336	0.4189		

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°

(Kendall and Andrews, 1921)

Herz, 1903 gives data at 26° which are lower than these. See comments above.

moles per liter sat. sol.		moles per liter sat. sol.		moles per liter sat. sol.	
HNO ₃	H ₃ BO ₃	HNO ₃	H ₃ BO ₃	HNO ₃	H ₃ BO ₃
0.0779	0.8820	1.580	0.6685	4.698	0.4471
0.1951	0.8610	2.372	0.5943	8.410	0.2963
0.5337	0.8028	3.118	0.5444	10.95	0.2305
0.9890	0.7361	3.806	0.4977	15.18	0.1973

THE SYSTEM B₂O₃ - HNO₃ - H₂O AT 30°

(Trombe, 1942)

The author draws a diagram of the system B₂O₃ - HNO₃ - H₂O at 30°, but does not give any numerical data. The solubility decreases slowly to a minimum of 0.6% at 30% HNO₃, and then remains practically constant at 0.95% up to 60% HNO₃, whence it increases fairly rapidly to a maximum

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of 25%. At this point the solution has the composition $B_2O_3 \cdot H_2O \cdot xHNO_3$ (about 91% HNO_3). The solubility then decreases up to 100% HNO_3 .

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25° AND AT 45° (Levi and Gilbert, 1927)

The solubility determinations were complicated by the ease with which highly supersaturated solutions were obtained, even at room temperature, in the high concentrations of sulfuric acid. In some cases the solutions stood for several weeks before any solid phase began to separate. The saturated solutions were analyzed by titrating with sodium hydroxide in the presence of *p*-nitrophenol as indicator, and after appearance of first yellow color, corresponding to the H_2SO_4 , a solution of mannite and a few drops of phenolphthalein were added and titration continued for boric acid.

The authors consider that the lower results of Herz, 1903, for this system are due to his use of a less accurate method. Similar observations have been made by Kendall and Andrews (see p. 263).

Results at 25°				Results at 45°			
d ₄ ²⁵ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₄ ⁴⁵ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	SO ₃	B ₂ O ₃			SO ₃	B ₂ O ₃	
1.017	0.00	3.08	H ₃ BO ₃	1.023	0.0	5.17	H ₃ BO ₃
1.039	2.90	2.79	"	1.029	0.47	5.07	"
1.088	9.12	2.18	"	1.036	1.93	4.83	"
1.160	17.65	1.54	"	1.086	8.58	3.74	"
1.284	30.62	0.97	"	1.097	10.18	3.51	"
1.412	41.78	0.71	"	1.231	25.48	1.89	"
1.479	46.80	0.65	"	1.446	44.87	0.13	"
1.625	55.84	2.69	"	1.628	52.25	7.07	"
...	54.66	6.09	"	1.671	54.13	8.33	B ₂ O ₃ ·SO ₃ ·4H ₂ O
1.668	53.50	8.12	"	1.685	56.65	6.14	"
...	55.74	7.70	B ₂ O ₃ ·SO ₃ ·4H ₂ O	...	60.89	4.89	"
1.617	54.73	10.32	"	...	62.66	6.85	"
...	51.87	15.45	"	1.800	57.22	13.56	"
...	47.27	20.93	"	...	58.87	23.60	3B ₂ O ₃ ·SO ₃ ·3H ₂ O
...	51.87	21.85	2B ₂ O ₃ ·SO ₃ ·3H ₂ O	...	57.70	19.25	"
...	57.32	18.34	"	...	60.43	17.99	"
...	63.36	15.23	"				
1.882	73.66	10.39	"				
...	87.72	4.82	"				

SOLUBILITY OF BORIC ACID IN 50% SULFURIC ACID SOLUTION
(Batuner, 1938)

Temp.	Gms. H_3BO_3 per 100 gms. sat. sol.	Gms. H_2SO_4 per 100 gms. sat. sol.
35°	1.68	50
45°	2.30	50
55°	2.74	50
65°	3.38	50

A solution saturated with both H_3BO_3 and $MgSO_4 \cdot H_2O$ and containing 50% H_2SO_4 has the following composition:

Temp.	Gms. H_3BO_3 per 100 gms. sat. sol.	Gms. $MgSO_4$ per 100 gms. sat. sol.	Gms. H_2SO_4 per 100 gms. sat. sol.
35°	2.02	3.75	50
45°	2.33	3.75	50
55°	2.86	3.75	50
65°	3.71	3.75	50

SOLUBILITY OF BORIC ACID IN CHROMIC ACID SOLUTIONS
(Gilbert, 1925 (25°, 45°); Bhagwat and Dhar, 1929 (30°))

Results at 25°			Results at 45°			Results at 30°	
d_{25}^4 of sat. sol.	Gms. per 100 gms. sat. sol.		D_{25}^4 of sat. sol.	Gms. per 100 gms. sat. sol.		Gm. Mols. per liter	
	CrO_3	B_2O_3		CrO_3	B_2O_3	CrO_3	$B(OH)_3$
1.052	4.90	2.79	1.038	2.40	4.76	0.009457	1.035
1.086	9.42	2.28	1.219	25.60	2.33	0.01017	1.035
1.156	18.07	1.58	1.528	53.80	1.85	0.04728	1.133
1.212	24.31	1.35	1.603	57.34	1.12	0.0947	1.213
1.296	33.05	1.02	1.603	57.50	0.87	0.1017	1.238
1.420	43.75	0.65	1.612	58.10	0.92		
1.699	59.90	0.16	1.674	61.56	0.90		
1.699	62.40	0.10					

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF PHOSPHORIC ACID AT 25°
(Levi and Gilbert, 1927)

The method of Kolthoff, 1922 for the very difficult determination of mixtures of boric and phosphoric acids was not found to give sufficiently accurate results. Although the use of sodium citrate and Kolthoff's pH value for the total acid end point was retained, a new procedure was adapted for the titration of the boric acid.

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d ₄ ²⁵ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₄ ²⁵ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	P ₂ O ₅	B ₂ O ₃			P ₂ O ₅	B ₂ O ₃	
1.042	3.63	2.55	H ₃ BO ₃	1.504	48.05	1.27	H ₃ BO ₃ + BPO ₄ (?)
1.048	4.34	2.53	"	(tr.pt.)			
1.190	21.51	1.12	"	1.516	48.51	1.20	BPO ₄ (?)
1.215	23.66	1.05	"	...	48.89	1.11	"
1.281	31.01	0.62	"	...	51.52	0.23	"
1.391	40.39	0.45	"	...	53.37	trace	"
1.434	43.70	0.68	"	1.645	58.68	"	"
				1.722	63.43	"	"

SOLUBILITY OF BORIC ACID IN ACETIC ACID SOLUTIONS

Results at 26°

(Herz, 1903a)

These data may be somewhat low because of the method of analysis which was used. See comment under "H₃BO₃ in HCl Solutions," p. 261.

Normality of Solutions		Gms. per 100 cc. Solution	
CH ₃ COOH	B(OH) ₃	CH ₃ COOH	B(OH) ₃
0	0.91	0	5.64
1	0.82	5	4.7
2	0.65	10	4.2
4	0.42	20	3.0
6	0.25	30	2.0

Results at 30°

(Dukelski, 1909)

The sat. solutions and residues were analyzed by titrating total acidity with 0.1 n NaOH and the acetic acid alone by an iodometric method.

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
B ₂ O ₃	(CH ₃ CO) ₂ O		B ₂ O ₃	(CH ₃ CO) ₂ O	
3.55	...	B(OH) ₃	0.41	84.48	B(OH) ₃ + (?)
3.18	7.78	"	0.46	84.44	" "
2.98	16.44	"	0.50	84.51	" "
2.34	28.96	"	4.98	82.13	B ₂ O ₃ · 2(CH ₃ CO) ₂ O
1.98	41.06	"	5.13	84.60	"
1.47	52.63	"	5.41	85.68	"
1.12	67.76	"	4.82	88.74	B ₂ O ₃ · 3(CH ₃ CO) ₂ O
1.01	73.96	"	4.71	89.98	"
0.54	80.67	"	4.06	92.68	"
0.45	84.55	" + (?)	3.10	95.76	"
0.39	84.65	" "			

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF d TARTARIC
ACID AND VICE VERSA

(Burgess and Hunter, 1929)

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	C ₄ H ₆ O ₆	H ₃ BO ₃			C ₄ H ₆ O ₆	H ₃ BO ₃	
0	0.0	1.9	H ₃ BO ₃	25	61.6	7.8	C ₄ H ₆ O ₆
"	33.1	6.8	"	"	60.4	4.2	"
"	55.8	10.0	"	"	59.6	0.0	"
"	62.3	11.1	" + C ₄ H ₆ O ₆	50	0.0	9.5	H ₃ BO ₃
"	58.6	6.4	C ₄ H ₆ O ₆	"	4.4	9.5	"
"	53.5	0.0	"	"	14.3	9.6	"
25	0.0	5.1	H ₃ BO ₃	"	15.2	9.8	"
"	2.8	5.3	"	"	19.6	10.0	"
"	9.5	5.8	"	"	25.1	10.0	"
"	14.9	6.2	"	"	28.6	10.2	"
"	24.6	7.3	"	"	37.8	10.7	"
"	31.3	8.8	"	"	51.2	12.8	"
"	39.4	9.6	"	"	60.1	14.8	"
"	49.1	10.5	"	"	65.0	15.8	"
"	65.1	13.0	" + C ₄ H ₆ O ₆	"	67.3	16.5	" + C ₄ H ₆ O ₆
"	63.7	10.7	C ₄ H ₆ O ₆	"	66.9	12.4	C ₄ H ₆ O ₆
"	63.3	9.9	"	"	66.7	9.3	"
				"	66.2	5.8	"
				"	66.1	0.0	"

Results of Herz (1911) differing somewhat from those above, using the d- and l-forms of the acid at 25°:

Gms. per 100 cc. Sat. Sol.			Gms. per 100 cc. Sat. Sol.		
C ₄ H ₆ O ₆		H ₃ BO ₃	C ₄ H ₆ O ₆		H ₃ BO ₃
0	d-Acid	5.59	9.45	l-Acid	6.11
11.25	"	6.20	18.90	"	6.48
22.5	"	6.63	37	"	7.23
45	"	7.48			

SOLUBILITY OF BORIC ACID IN OXALIC AND LACTIC ACID SOLUTIONS AT 25°

In Aq. Oxalic Acid
(Herz, 1910)

In Aq. Lactic Acid
(Mueller and Abegg, 1906)

Gms. per 100 cc. Sat. Sol.			Solvent:		Gms. H ₃ BO ₃ per 100 cc Sat. Sol.
H ₂ C ₂ O ₄	H ₃ BO ₃	Solid Phase	d ₂₅ ²⁵ C ₃ H ₆ O ₃	Mol. % C ₃ H ₆ O ₃	
2.26	6.17	H ₃ BO ₃	1.0252	2.321	6.64
5.36	6.70	"	1.0722	6.819	9.98
12.39	7.44	" + H ₂ C ₂ O ₄	1.1405	18.77	11.53
11.27	3.45	H ₂ C ₂ O ₄	1.2023	36.33	12.90
10.84	0.97	"			
10.77	0.55	"			
10.63	0	"			

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SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS HYDROGEN PEROXIDE AT 18° (Menzel, 1927)

A warm solution containing sufficient $B(OH)_3$ to yield a solid phase when cooled to 18° was stirred several hours after the addition of strong H_2O_2 . After attainment of equilibrium 2.0 cc. portions of the supernatant solution were withdrawn for analysis. A further amount of H_2O_2 was added and the operation repeated. Very great accuracy is not claimed for the results.

Gm. Mols. per liter		Gm. Mols. per liter	
H_2O_2	$B(OH)_3$	H_2O_2	$B(OH)_3$
0.0	0.741	0.583	0.717
0.057	0.734	0.815	0.709
0.115	0.730	1.35	0.703
0.178	0.728	1.80	0.693
0.273	0.724	2.33	0.684

SOLUBILITY OF BORIC ACID IN AQUEOUS SALT SOLUTIONS

- (1) Linderstrom-Lang, 1924
(2) Kolthoff, 1926

In NaCl Solutions

Results given in moles per liter

Solvent: moles NaCl per liter	(1) 12°	(1) 17.85°	(2) 20°	(1) 23.85°	(Herz, 1910) 25°
	moles H_3BO_3 per liter sat. sol.				moles per liter sat. sol.
					NaCl H_3BO_3
0.0	0.6061	0.7219	0.736	0.8633	0.0 0.904
0.4	.6033	...	...	.8514	0.34 0.872
0.8	.6000	.7116	...	.8426	0.68 0.857
1.0	...	...	.724	...	1.03 0.840
1.6	.5953	.7008	...	.8223	1.37 0.833
2.4	...	.6889	...	...	1.71 0.824
3.2	.5794	.6769	...	.7944	2.57 0.820

(Cont.)

Results given on a weight basis

at 25° (Bogdan, 1902-30)

at 35° (Teeple, 1929)

gms. per 100 gms. H ₂ O		Solid Phase	gms. per 100 gms. H ₂ O		Solid Phase
NaCl	H ₃ BO ₃		NaCl	H ₃ BO ₃	
0	5.75	H ₃ BO ₃	36.8	8.2	H ₃ BO ₃ + NaCl
1.0	5.75	"	at 75° (Teeple, 1929)		
2.0	5.74	"			
4.0	5.72	"			
6.0	5.72	"	38.5	22.2	H ₃ BO ₃ + NaCl
8.0	5.71	"			

Results with Na₂SO₄
also present

	NaCl	Na ₂ SO ₄	H ₃ BO ₃	
(35°)	33.2	11.9	9.6	H ₃ BO ₃ + NaCl + Na ₂ SO ₄
(75°)	35.5	12.4	25.0	" + " + "

Results with Na₂B₄O₇
also present

	NaCl	Na ₂ B ₄ O ₇	H ₃ BO ₃	
(35°)	36.3	1.2	9.4	H ₃ BO ₃ + NaCl + Na ₂ B ₄ O ₇

Data for the system H₃BO₃ + NaCl + H₂O at -20°, -10°, 10°, 20° and 25° are given by Palkin and Goloachchapov (1939). The eutectic occurs at -21.4° and the saturated solution contains 22.9% NaCl and 1.45% H₃BO₃.

In KCl Solutions

(1) Linderstrom-Lang (1924)

(2) Kolthoff (1926)

Results given in moles per liter

Solvent: moles KCl per liter	(1) 12°	(1) 17.85°	(2) 20°	(1) 23.85°	(Herz, 1910) 25° moles per liter sat. sol.
	moles H ₃ BO ₃ per liter				KCl H ₃ BO ₃
0.0	0.6061	0.7219	0.736	0.8633	0.0 0.904
0.7	.6403	.7558	...	.8960	0.269 .916
1.0	...	...	.790	...	0.537 .929
1.4	.6714	.78849306	0.805 .946
2.1	.7028	.81999609	1.07 .953
2.8	.7379	.85389959	1.34 .970
					2.01 1.010
					2.69 1.050

(Cont.)

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Results given on a weight basis

at 25° (Bogdan, 1902-03)

at 35° (Teeple, 1929)

gms. per 100 gms. H ₂ O			Solid Phase	gms. per 100 gms. H ₂ O		Solid Phase
KCl	H ₃ BO ₃			KCl	H ₃ BO ₃	
0	5.75	H ₃ BO ₃		41.0	11.6	H ₃ BO ₃ + KCl
1.0	5.80	"				
2.0	5.86	"				
4.0	4.98	"				
6.0	6.12	"				
8.0	6.29	"				

with K₂SO₄ also present

KCl	K ₂ SO ₄	H ₃ BO ₃	
39.9	2.8	12.1	H ₃ BO ₃ + KCl + K ₂ SO ₄

with K₂B₁₀O₁₆ also present

KCl	K ₂ B ₁₀ O ₁₆	H ₃ BO ₃	
40.7	2.4	7.1	H ₃ BO ₃ + KCl + K ₂ B ₁₀ O ₁₆

at 47.5° (Levi and Aguzzi, 1938)

KCl	H ₃ BO ₃	
50.9	23.4	H ₃ BO ₃ + KCl

In LiCl Solutions

(1) Linderstrom-Lang, 1924
(2) Kolthoff, 1926

Solvent: moles KCl per liter	(1) 12°	(1) 17.85°	(2) 20°	(1) 23.5°	(Herz, 1910) 25° moles per liter sat. sol.
	moles H ₃ BO ₃ per liter				LiCl H ₃ BO ₃
0.0	0.6061	0.7219	0.736	0.8633	0.0 0.904
0.669	.5276	.6379	...	.7622	0.472 .840
1.3	...	...	.56	...	0.943 .784
1.338	.4663	.5642	...	.6714	1.414 .719
2.676	.3683	.4492	...	.5396	1.885 .658
4.113	.2927	.3126	...	.4380	2.36 .606
					3.54 .485

In RbCl SolutionsResults at 18°
(Linderstrom - Lang, 1924)

moles RbCl per liter of solvent	moles H ₃ BO ₃ dissolved per liter
0.0	0.7313
0.6	0.7689
1.2	0.8083
2.4	0.8880

Results at 25°
(Herz, 1910)

moles per liter sat. sol.		moles per liter sat. sol.	
RbCl	H ₃ BO ₃	RbCl	H ₃ BO ₃
0.0	0.904	0.828	0.933
0.165	0.905	1.24	0.954
0.331	0.910	1.66	0.986
0.496	0.916	2.48	1.58
0.662	0.924		

In Solutions of other Chlorides (Linderstrom-Lang, 1924)

At 17.85°

BaCl ₂		MgCl ₂		CaCl ₂	
moles BaCl ₂ per liter solvent	moles H ₂ BO ₃ per liter	moles MgCl ₂ per liter solvent	moles H ₃ BO ₃ per liter	moles CaCl ₂ per liter solvent	moles H ₃ BO ₃ per liter
0.0	0.7219	0.0	0.7219	0.0	0.7219
0.4	0.6769	0.248	0.6562	0.299	0.6530
0.6	0.6594	0.495	0.5973	0.5 *	0.628
0.8	0.6451	0.990	0.4997	0.598	0.5937
		1.979	0.3500	1.195	0.4890
				2.309	0.3417

at 18°

CsCl	
moles CsCl per liter solvent	moles H ₃ BO ₃ per liter
0.0	0.7313
0.732	0.7725
1.455	0.8203
2.177	0.8713

*Kolthoff, 1926 at 18°

In K₂SO₄ Solutions

t°	gms. per 100 gms. H ₂ O		Solid Phase	Author
	K ₂ SO ₄	H ₃ BO ₃		
25°	0	5.75	H ₃ BO ₃	(Bogdan, 1902-03)
	1.0	5.92	"	"
	2.0	6.10	"	"
	4.0	6.50	"	"
	6.0	6.92	"	"
	8.0	7.40	"	"
35°	21.2	12.5	H ₃ BO ₃ + K ₂ SO ₄	(Teepie, 1929)

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In Na_2SO_4 Solutions

t°

18° a 0.5M Na_2SO_4 solution will dissolve 0.880 moles H_3BO_3 per liter (Koltthoff, 1926)

	gms. per 100 gms. H_2O		Solid Phase	
	Na_2SO_4	H_3BO_3		
20.5°	25.3	7.6	$\text{H}_3\text{BO}_3 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	(Teeple, 1929)
23.5°	31.2	8.9	" + "	(")
0 25°	0	5.75	H_3BO_3	(Bogdan, 1902-03)
	1.0	5.88	"	"
	2.0	6.00	"	"
	4.0	6.33	"	"
	6.0	6.70	"	"
	8.0	7.10	"	"
28.5°	47.3	10.6	$\text{H}_3\text{BO}_3 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	(Teeple, 1929)
35°	53.0	13.1	$\text{H}_3\text{BO}_3 + \text{Na}_2\text{SO}_4$	"
75°	51.7	31.4	" + "	"

In KI Solutions

(Linderstrom-Lang, 1924)

Results at 17.85°

moles KI per liter solvent	0.0	0.6	1.0	1.2	1.8	2.4
moles H_3BO_3 per liter	0.7219	0.7219	0.745*	0.7239	0.7223	0.7175

*Koltthoff, 1926 at 18°. In pure H_2O , Koltthoff found 0.736.

In NaNO_3 and KNO_3 Solutions

18° 1 liter of 1M KNO_3 solution dissolve 0.817 moles H_3BO_3 . (H_2O alone dissolves 0.736 moles) (Koltthoff, 1926)

25°	(Bogdan, 1902-03)			
	gms. per 100 gms. H_2O		gms. per 100 gms. H_2O	
	NaNO_3	H_3BO_3	KNO_3	H_3BO_3
	0.0	5.75	0.0	5.75
	1.0	5.78	1.0	5.81
	2.0	5.81	2.0	5.88
	4.0	5.87	4.0	6.04
	6.0	5.95	6.0	6.20
	8.0	6.02	8.0	6.37

In KF Solutions at 30° (Hhagwat and Dhar, 1929)

moles per liter sat. sol.:				
KF	:	0.0	0.08217	0.1643
H_3BO_3	:	1.029	1.025	1.330
				1.566

In Solutions of Various Other Salts (see both tables)

Data of Kolthoff, 1926 at 18°

Salt	moles salt per liter solvent	moles H ₃ BO ₃ per liter	Salt	moles salt per liter solvent	moles H ₃ BO ₃ per liter
None	0.0	0.736	Na oxalate	0.25	0.92
KSCN	1.0	0.778	Na lactate	0.1	0.84
KBr	1.0	0.768	"	0.5	1.31
K ₃ Fe(CN) ₆	0.33	0.760	"	1.0	1.92
K ₄ Fe(CN) ₆	0.25	0.850	Na citrate	0.1	0.93
Na acetate	1.0	1.09	"	0.25	1.17
Na benzoate	0.5	0.96	"	0.50	1.52
NaK Tartarate	0.05	0.835	Na salicylate	0.20	0.985
"	0.25	1.23	"	0.50	1.350
"	0.50	1.69			

Data of Dhar, 1926 at 22°

An excess of boric acid was shaken with the aqueous salt solutions. The flasks stood in a thermostat at 22°. It is not clear whether constant or intermittent shaking was employed. The results are given in terms of excess of boric acid dissolved in the salt solution, but the figure for the amount dissolved in water alone is not given.

Used salt solution	Gm. equiv. of salt per liter	Excess H ₃ BO ₃ dissolved, gm. equiv. expressed in per liter	Dissociation constant
Sodium benzoate C ₆ H ₅ COONa	0.0283	0.0020	0.3 x 10 ⁻⁵
" "	0.0565	0.0032	0.3 x 10 ⁻⁵
" "	0.1130	0.0052	0.2 x 10 ⁻⁵
Sodium salicylate C ₆ H ₄ ·OH·COONa(o)	0.0544	0.0005	1.1 x 10 ⁻⁴
" "	0.1087	0.0004	1.0 x 10 ⁻⁴
" "	0.2173	0.0013	0.6 x 10 ⁻⁴
Sodium acetate CH ₃ COONa	0.0475	0.0025	0.4 x 10 ⁻⁵
" "	0.0950	0.0035	0.4 x 10 ⁻⁵
" "	0.1900	0.0015	0.6 x 10 ⁻⁶
Sodium butyrate C ₃ H ₇ ·COONa	0.0375	0.0018	0.4 x 10 ⁻⁵
" "	0.0750	0.0040	0.2 x 10 ⁻⁵
" "	0.1500	0.0102	0.7 x 10 ⁻⁶

SOLUBILITY OF BORIC ACID IN SOLUTIONS SATURATED WITH OTHER SALTS
(Teeple, 1929)

Except for data involving Na and K borates, this data is also given in the preceding tables.

(Cont.)

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t°	Per 100 Gms. H ₂ O				Solid Phase
35	8.2 gms.	H ₃ BO ₄	+ 36.8 gms.	NaCl	H ₃ BO ₃ + NaCl
"	13.1 "	"	+ 53.0 "	Na ₂ SO ₄	" + Na ₂ SO ₄
"	9.6 "	"	+ 11.9 "	" + 33.2 gms. NaCl	" + Na ₂ SO ₄ + NaCl
75	22.2 "	"	+ 38.5 "	NaCl	" + NaCl
"	31.4 "	"	+ 51.7 "	Na ₂ SO ₄	" + Na ₂ SO ₄
"	25.0 "	"	+ 12.4 "	" + 35.5 gms. NaCl	" + " + NaCl
35	11.6 "	"	+ 41.0 "	KCl	" + KCl
"	12.5 "	"	+ 21.2 "	K ₂ SO ₄	" + K ₂ SO ₄
"	12.1 "	"	+ 2.8 "	" + 39.9 gms. KCl	" + " + KCl
"	7.1 "	"	+ 2.4 "	K ₂ B ₁₀ O ₁₆	" + KB ₈
"	11.0 "	"	+ 0.3 "	" + 40.7 gms. KCl	" + KB ₈ + KCl
0	18.4 "	"	+ 8.4 "	Na ₂ B ₄ O ₇	" + NaB ₁₀
"	9.4 "	"	+ 1.2 "	" + 36.3 gms. NaCl	" + " + NaCl
20.5	7.6 "	"	+ 25.3 "	Na ₂ SO ₄	" + Na ₁₀
"	9.8 "	"	+ 25.8 "	" + 1.9 gm. Na ₂ B ₄ O ₇	" + " + NaB ₁₀
23.5	8.9 "	"	+ 31.2 "	"	" + "
"	12.6 "	"	+ 6.2 "	Na ₂ B ₄ O ₇	" + NaB ₁₀
"	10.9 "	"	+ 1.9 "	" + 31.3 gms. Na ₂ SO ₄	" + " + Na ₁₀
28.5	10.6 "	"	+ 47.3 "	Na ₂ SO ₄	" + Na ₁₀
"	14.9 "	"	+ 7.0 "	Na ₂ B ₄ O ₇	" + NaB ₁₀
"	12.1 "	"	+ 1.7 "	" + 47.8 gms. Na ₂ SO ₄	" + " + Na ₁₀
35	14.9 "	"	+ 2.3 "	" + 52.1 gms. Na ₂ SO ₄	" + " + Na ₂ SO ₄

KB₈ = K₂B₁₀O₁₆ · 8H₂O; NaB₁₀ = Na₂B₁₀O₁₆ · 16H₂O; Na₁₀ = Na₂SO₄ · 10H₂O

THE SYSTEM BORIC ACID - POTASSIUM METABORATE - WATER
(Carpeni, 1955; Teeple, 1929 (at 35°))

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
B ₂ O ₃	KBO ₂	B ₂ O ₃		KBO ₂	B ₂ O ₃	KBO ₂					
Results at 5°			Results at 45°			Results at 95°					
1.7	0.0	A	5.2	0.0	A	14.2	0.0	A			
2.1	0.3	A + B	6.4	0.9	A + B	16.7	3.0	A + B			
1.1	0.7	B	3.8	2.3	B	12.7	6.3	B			
1.7	2.5	B	4.0	3.4	B	12.2	7.4	B			
1.8	2.9	B	5.5	6.4	B	16.6	17.2	B			
3.1	6.2	B + D	6.6	8.9	B	18.3	20.6	B			
2.4	5.6	D	8.7	12.9	B	20.4	23.2	B + C			
1.5	5.7	D	10.2	15.9	B	17.2	21.1	C			
1.1	7.4	D	11.6	18.5	B + D	15.6	19.9	C			
0.8	15.0	D	8.7	16.7	D	13.6	19.2	C			
0.8	17.3	D	6.5	15.3	D	13.0	19.1	C			
0.7	29.8	D	5.2	15.3	D	10.6	23.2	C			
0.8	43.9	D + E	4.4	15.6	D	10.4	24.6	C			
0.02	42	E	3.5	17.1	D	10.9	30.0	C + D			
			2.9	18.3	D	12.5	47.1	D			
			2.4	28.1	D	8.4	33.4	D			
			2.0	31.7	D	7.2	35.6	D			
			1.8	37.7	D	6.9	44.8	D			
			2.1	46.9	D + E	6.6	50.2	D			
			0.0	45.5	E	6.8	53.3	D + E			
						5.2	50.3	E			

gms. per 100 gms. sat. sol.			Solid Phase	gms. per 100 gms. sat. sol.			Solid Phase	gms. per 100 gms. sat. sol.			Solid Phase
B ₂ O ₃	KBO ₂			B ₂ O ₃	KBO ₂			B ₂ O ₃	KBO ₂		
Results at 25°				Results at 35°				Results at 85°			
3.1	0.0	A		3.66	0.81	A + B		9.1	0.0	A	
3.2	0.2	A						15.6	2.9	A + B	
3.7	0.4	A + B						10.0	6.4	B	
3.2	0.5	B						12.6	12.1	B	
2.3	0.8	B						15.1	16.8	B	
2.1	1.2	B						16.6	18.9	B	
2.4	1.8	B						17.9	21.9	B + C	0
2.7	3.1	B						15.3	19.7	C	
3.2	4.3	B						12.6	19.8	C	
3.6	5.3	B						11.1	22.2	C	
5.6	9.5	B						10.0	28.9	C + D	
6.1	10.3	B + D						7.6	32.7	D	
5.0	9.8	D						7.0	34.3	D	
3.4	9.4	D						6.3	35.6	D	
3.0	9.7	D						6.0	41.3	D	
2.2	10.5	D						5.8	43.4	D	
2.0	11.8	D						5.1	52.8	D + E	
1.7	13.1	D						0.6	49.4	D	
1.5	15.6	D									
1.3	18.2	D									
1.0	20.1	D									
1.2	30.3	D									
1.4	44.1	D + E									
0.0	43.3	E									

A = H₃BO₃
B = KB₃O₈·4H₂O
C = K₂HB₃O₇·3H₂O
D = K₂B₄O₇·4H₂O
E = KH₂BO₃

SYSTEMS OF BORIC ACID WITH ARSENATES AND PHOSPHATES
 (Levi and Aguzzi, 1938)

Results for H₃BO₃ + KH₂AsO₄ + H₂OResults for H₃BO₃ + NaH₂AsO₄ + H₂O

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	H ₃ BO ₃	KH ₂ AsO ₄			H ₃ BO ₃	NaH ₂ AsO ₄	
0	2.6	0.0	H ₃ BO ₃	0	2.6	0.0	H ₃ BO ₃
	3.3	25.3	" + KH ₂ AsO ₄		4.4	119.3	" + NaH ₂ AsO ₄
	0.0	23.9	"		0.0	117.4	"
25	5.4	0.0	H ₃ BO ₃	25	5.4	0.0	H ₃ BO ₃
	8.3	39.1	" + KH ₂ AsO ₄		11.2	250.0	" + NaH ₂ AsO ₄
	0.0	35.0	"		0.0	222.4	"
50	11.5	0.0	H ₃ BO ₃	50	11.5	0.0	H ₃ BO ₃
	27.5	65.6	" + KH ₂ AsO ₄		45.0	320.0	" + NaH ₂ AsO ₄
	0.0	53.2	"		0.0	284.1	"

(Cont.)

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SYSTEMS OF BORIC ACID WITH ARSENATES AND PHOSPHATES (Cont.)

Results for $\text{H}_3\text{BO}_3 + \text{KH}_2\text{PO}_4 + \text{H}_2\text{O}$

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	H_3BO_3	KH_2PO_4	
0	2.6	0.0	H_3BO_3
	3.5	16.5	" + KH_2PO_4
	0.0	14.3	"
29.9	6.4	0.0	H_3BO_3
	8.9	33.7	" + KH_2PO_4
	0.0	28.6	"
47.5	11.0	0.0	H_3BO_3
	26.2	53.4	" + KH_2PO_4
	13.4	40.8	"

Results for $\text{H}_3\text{BO}_3 + \text{NaH}_2\text{PO}_4 + \text{H}_2\text{O}$

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	H_3BO_3	NaH_2PO_4	
0	2.6	0.0	H_3BO_3
	4.4	58.1	" + NaH_2PO_4
	0.0	57.7	"
29.9	6.4	0.0	H_3BO_3
	11.2	108.3	" + NaH_2PO_4
	0.0	106.0	"
47.5	11.0	0.0	H_3BO_3
	37.2	187.6	" + NaH_2PO_4
	0.0	158.3	"

THE SYSTEM BORIC ACID - CALCIUM GLUTONATE - WATER AT 20°
(DeCarli, 1931)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$(\text{C}_6\text{H}_{11}\text{O}_7)_2\text{Ca}$	B_2O_3		$(\text{C}_6\text{H}_{11}\text{O}_7)_2\text{Ca}$	B_2O_3	
3.57	3.15	$\text{B}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$	33.85	3.03	$(\text{C}_6\text{H}_{11}\text{O}_7)_2\text{Ca}$
12.60	3.95	"	32.44	2.67	"
21.18	4.91	"	30.60	2.53	"
30.02	5.73	"	27.40	2.23	"
52.97	6.89	"	24.90	1.94	"
52.97	8.28	"	18.12	1.29	"
57.44	8.80	"	14.08	0.95	"
39.04	3.67	$(\text{C}_6\text{H}_{11}\text{O}_7)_2\text{Ca}$	11.10	0.78	"
36.04	3.13	"	7.51	0.49	"

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ALCOHOLS

In Aq. Methyl Alcohol
at 25°

(Mueller and Abegg, 1906)

Solvent		Gms. H_3BO_3 per 100 cc Sat. Sol.
$\frac{15}{d_4}$	Wt. % CH_3OH	
0.9691	19	5.55
0.9340	41.5	6.27
0.9185	50	6.81
0.9019	58	7.20
0.8842	66	8.10
0.7960	100	17.99*

In Aq. Propyl Alcohol at 25°

(Mueller and Abegg, 1906)

(Bogdan,
1902-03)

Solvent		$\frac{25}{d_4}$ of Sol.	Gms. H_3BO_3 per 100 cc Sat. Sol.	gms. per 100 gms. sat. sol.
$\frac{25}{d_4}$	Wt. % $\text{C}_3\text{H}_7\text{OH}$			
0.9043	50.83	0.9193	3.99	0 5.75
0.9231	79.41	0.8570	2.83	1.0 5.80
0.8133	95.5	0.8466	3.58	2.0 5.85
0.8010	100	0.8297	5.96	4.0 5.94
				6.0 6.03

(Cont.)

In Aq. Ethyl Alcohol
(Seidell, 1908)

(Data at 25° are also given by Mueller and Abegg, 1906)

Results at 15°				Results at 25°			
Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. H ₃ BO ₃ per 100 Gms. Sat. Sol.	d ₁₅ of Sat. Sol.		Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. per 100 Gms. Sat. Sol.		
					H ₃ BO ₃ C ₂ H ₅ OH	d ₂₅ of Sat. Sol.	
0	4.11	1.014		0	5.42 0	1.018	
8.9	3.90	0.9986		20	5.20 18.96	0.987	0
32.0	3.58	0.9658		40	5.10 37.96	0.952	
51.0	3.48	0.9268		60	5.00 57.00	0.908	
70.2	3.22	0.8820		80	5.05 75.96	0.862	
91.3	5.06	0.8389		85	5.30 80.50	0.853	
93.6	5.70	0.8370		90	6.20 84.4	0.842	
99.8	9.18	0.8356		95	8.00 87.4	0.838	
				100	11.20 88.8	0.838	

In Aq. Isobutyl Alcohol at 25°
(Mueller and Abegg, 1906)

In Aq. Isoamyl Alcohol at 15°
(Mueller and Abegg, 1906)

Solvent		d ₄ ²⁵ of Sat. Sol.	Gms. H ₃ BO ₃ per 100 cc Sat. Sol.	Solvent		d ₄ ²⁵ of Sat. Sol.	Gms. H ₃ BO ₃ per 100 cc Sat. Sol.
d ₄ ²⁵	Mol. % C ₄ H ₉ OH			d ₄ ²⁵	Mol. % C ₅ H ₁₁ OH		
0.9923	0.70	1.0124	5.48	0.9943	0.448	1.0132	5.48
0.9853	2.15	1.0038	5.32	0.9936	0.520	1.0125	5.46
0.9855	2.18	1.0046	5.32	0.9931	0.525*	1.0123	5.46
0.8173	71.4	0.8351	2.00	0.8232	67.26†	0.8290	1.60
0.8133	77.1	0.8220	2.15	0.8183	75.54	0.8253	1.69
0.8081	85.6	0.8195	2.61	0.8142	83.40	0.8223	1.98
0.7984	100	0.8172	4.30	0.8068	100	0.8220	3.54

† = Amyl alcohol sat. with H₂O. * = H₂O sat. with amyl alcohol.

In Amyl Alcohol at 15°
(Auerbach, 1903)

One liter H₂O saturated with amyl alcohol dissolves 55.5 gms. H₃BO₃.

(Cont.)

In Aq. Solutions of Glycerol

Results at 20°
(Holm, 1921, 1921a, 1922)
These data are high in
comparison to the results
at 25° at right

Results at 25°
(Herz and Knoch, 1905;
Mueller and Abegg, 1906 (*))
Saturated Solution

Solvent			Solvent			gms. H ₃ BO ₃ per 100		
Wt. %	Density	Sat. Sol'n. Wt. %	Wt. %	Density		ml.	gms.	Density
C ₃ H ₈ O ₃		H ₃ BO ₃	C ₃ H ₈ O ₃					
86.5	1.2326	12.11	0	...		5.59	5.50	1.017
98.5	1.2645	19.9	7.15	...		5.59	5.38	1.038
			20.44	...		5.62	5.28	1.063
			31.55	...		5.76	5.29	1.090
			40.95	...		6.02	5.41	1.113
			48.7	...		6.39	5.64	1.133
			60.0*	1.1574		7.49	6.39	1.171
			69.2	...		8.69	7.32	1.187
			81.8*	...		13.22	10.79	1.226
			90.0*	1.2370		18.35	14.64	1.253
			96.6*	1.2531		23.44	18.45	1.271
			100.0	...		24.20	19.02	1.272

THE SYSTEM BORIC ACID - MANNITOL - WATER AT 25°

Results differing somewhat from these are given by Abegg (1906).
Additional determinations at 30° are given by Ageno and Valla.



Results of Ageno and Valla, 1912, 1913						Results of Hermans, 1925		
Gms. per 100 cc Sat. Sol.		Solid Phase	Gms. per 100 cc Sat. Sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₃ BO ₃	C ₆ H ₁₄ O ₆		H ₃ BO ₃	C ₆ H ₁₄ O ₆		HBO ₂	Mannitol	
5.50	0	H	8.70	25.65	H	4.25	5.43	H
5.90	1.82	H	9.43	32.43	H + M	4.68	11.5	H
6.29	5.46	H	7.71	27.97	M	5.07	17.2	H
6.44	7.28	H	5.75	25.65	M	5.28	20.0	H
6.64	9.11	H	4.92	24.65	M	5.52	22.5	H
6.83	10.93	H	3.46	23.03	M	5.70	25.1	H + M
7.08	12.75	H	2.87	22.98	M	5.68	24.4	M
7.27	14.57	H	1.64	20.80	M	5.40	25.4	M
7.71	18.99	H	0	19.58	M	5.13	24.7	M
						2.27	20.8	M
						0.0	17.7	M

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF DULCITE
(1,2,3,4,5,6-hexanehexol) at 25°
(Mueller and Abegg, 1906)

Solvent		d_{4}^{25}	Mol. % $C_6H_8(OH)_6$	d_{4}^{25} of Sat. Sol.	Gms. H_3BO_3 per 100 cc Sat. Sol.
d_{4}^{25}					
0.9995	0.065			1.0686	5.50
1.0018	0.130			1.0312	5.63
1.0060	0.260			1.0260	5.81

SOLUBILITY OF BORIC ACID IN AQUEOUS ACETONE SOLUTIONS

Results at 20° (Herz and Knoch, 1904)			Results at 25° (Bogdan, 1902-03)	
H_3BO_3 per 100 cc Solution			Gms. per 100 gms. H_2O	
cc Acetone per 100 cc Solvent	Millimols	Grams	$(CH_3)_2CO$	H_3BO_3
0	79.15	4.91	0	5.75
20	81.71	5.07	1.0	5.84
30	83.35	5.17	2.0	5.93
40	82.72	5.13	4.0	6.12
50	81.62	5.06	6.0	6.29
60	76.40	4.74		
70	67.62	4.19		
80	55.05	3.41		
100	8.06	0.50		

SOLUBILITY OF BORIC ACID IN SOLUTIONS OF:

Urea at 25° (Bogdan, 1902-03)		cis-Tetrahydronaphthalene- 1,2 diol at 25° (Hermans, 1925)		Solid Phase
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		
$CO(NH_2)_2$	H_3BO_3	HBO_2	Diol	
0	5.75	3.94	1.85	Boric Acid
1.0	5.84	3.92	2.08	"
2.0	5.93	3.90	2.14	" + Diol
4.0	6.13	3.29	2.10	Diol
6.0	6.31	1.55	1.99	"

Data for the system boric acid, phenol and water are given by Timmermans (1907).

B BORON

DISTRIBUTION OF BORIC ACID BETWEEN WATER AND AMYL ALCOHOL Results at 15°. (Mueller and Abegg, 1906)

Millimols H ₃ BO ₃ per Liter		Gms. H ₃ BO ₃ per 100 cc		Millimols H ₃ BO ₃ per Liter		Gms. H ₃ BO ₃ per 100 cc	
Aq. Layer	Alcohol Layer	Aq. Layer	Alcohol Layer	Aq. Layer	Alcohol Layer	Aq. Layer	Alcohol Layer
894	264	5.44	1.64	427.4	127.6	2.65	0.79
607.2	176.4	3.76	1.09	372	110	2.31	0.68
589.3	177.4	3.65	1.10	289.1	84.0	1.79	0.53

0

Results at 25°. (Fox, 1903)

Data agreeing with those of Fox at 25° are also given by Mueller and Abegg, 1906.

Millimols H ₃ BO ₃ in		Gms. H ₃ BO ₃ in 100 cc.		Millimols H ₃ BO ₃ in		Gms. H ₃ BO ₃ in 100 cc.	
Aq. Layer	Alcoholic Layer	Aq. Layer	Alcoholic Layer	Aq. Layer	Alcoholic Layer	Aq. Layer	Alcoholic Layer
265.8	76.6	1.648	0.475	87.9	33.2	0.545	0.206
196.5	59.5	1.219	0.369	75.2	22.7	0.466	0.141
159.6	47.5	0.990	0.294	64.6	19.76	0.400	0.123
126.0	37.1	0.781	0.230				

Results at 35°

One determination at 35° gave 0.907 gm. H₃BO₃ per 100 cc. aq. layer and 0.274 gm. per 100 cc. alcohol layer.

DISTRIBUTION OF BORIC ACID BETWEEN AQUEOUS SODIUM CHLORIDE SOLUTIONS AND AMYL ALCOHOL AT 25° (Mueller and Abegg, 1906)

Gms. per 100 cc.:					Gms. per 100 cc.:				
Aq. Layer		Alcohol Layer		d ₄ ²⁵ of Alcohol Layer	Aq. Layer		Alcohol Layer		d ₄ ²⁵ of Alcohol Layer
NaCl	H ₃ BO ₃	H ₂ O	H ₃ BO ₃		NaCl	H ₃ BO ₃	H ₂ O	H ₃ BO ₃	
0	5.46	7.39	1.65	0.8296	16.64	5.13	4.71	1.79	0.8247
5.53	5.37	6.40	1.65	0.8277	17.90	5.02	4.31	1.79	0.8241
8.72	5.27	5.90	1.67	0.8268	20.36	5.02	4.19	1.87	0.8240
10.91	5.23	5.46	1.69	0.8259	23.52	4.97	3.59	1.96	0.8233
13.84	5.16	5.15	1.77	0.8254	25.03	4.95	3.20	1.88	0.8229

DISTRIBUTION OF BORIC ACID BETWEEN WATER AND MIXTURES OF AMYL
ALCOHOL AND CARBON DISULFIDE AT 25°
(Herz and Kurzer, 1910)

75 Vol. % $C_5H_{11}OH$ + 25 Vol. % CS_2 Gms. H_3BO_3 per 100 cc.		50 Vol. % $C_5H_{11}OH$ + 50 Vol. % CS_2 Gms. H_3BO_3 per 100 cc.		25 Vol. % $C_5H_{11}OH$ + 95 Vol. % CS_2 Gms. H_3BO_3 per 100 cc.	
Aqueous Layer	$C_5H_{11}OH$ + CS_2 Layer	Aqueous Layer	$C_5H_{11}OH$ + CS_2 Layer	Aqueous Layer	$C_5H_{11}OH$ + CS_2 Layer
0.387	0.095	0.469	0.059	0.433	0.053
0.743	0.171	0.839	0.161	0.910	0.108
1.143	0.266	1.207	0.226	1.343	0.164
1.590	0.365	1.791	0.344	1.940	0.238

0

SOLUBILITY AND PARTITION COEFFICIENTS OF BORIC ACID
IN ETHER - WATER MIXTURES
(Bachelet, Cheylan, and LeBris, 1947)

- 0.073 gms. dissolve in 100 gms. Anhydrous Ether at 12°.
- 0.1 gms. dissolve in 100 gms. of Ether saturated with water at 14°.
- 0.16 gms. dissolve in 100 gms. of Ether containing 7.2 gms. $UO_2(NO_3)_2 \cdot 6H_2O$ at 16°.
- 0.14 gms. dissolve in 100 gms. of Ether containing 6.6 gms. $UO_2(NO_3)_2 \cdot 6H_2O$ at 18°.

Partition Coefficients

10 cc of water, containing the listed amounts of boric acid were shaken with 100 cc of ether saturated with water.

Temp.	Gms. H_3BO_3	Partition Coefficient
12°	0.36	0.035
14°	0.2	0.024
14°	0.072	0.025
14°	0.072	0.028
15°	0.34	0.038

B BORON

SOLUBILITY OF BORIC ACID IN ANHYDROUS ORGANIC SOLVENTS

Solvent	t°	Saturated solution		Author
		Wt. % H ₃ BO ₃	Density	
Methanol	25	20.20	0.8904	(Mueller and Abegg, 1906)
Ethanol	25	11.20	0.838	(Seidell, 1908)
Propanol	25	7.18	0.8297	(Mueller and Abegg, 1906)
i-Butanol	25	5.26	0.8172	(")
i-Amyl alcohol	15	4.31	0.8220	(")
Furfural	25	0.05	....	(Trimble, 1941)
0 Dichloroethylene	15	0.006	....	(Wester and Brunis, 1914)
Trichloroethylene	15	0.016	....	( " )
Glycerol	0	13.71	....	(Hooper, 1882)
	10	16.00	....	( " )
	20	18.21	....	( " )
	30	20.75	....	( " )
	40	23.17	....	( " )
	50	25.95	....	( " )
	60	28.41	....	( " )
	70	30.72	....	( " )
	80	32.61	....	( " )
	90	34.70	....	( " )
	100	36.36	....	( " )
Acetone	20	0.50	(gms. per 100 ml. sat. sol.)	(Herz and Knoch, 1904)

SOLUBILITY OF H₃BO₃ IN LIQUID AMMONIA AND HYDRAZINE

Solvent	t°	Solubility	Author
Liquid Ammonia	25°	1.92 gms. H ₃ BO ₃ per 100 gms. HN ₃	(Hunt and Boncyk, 1933)
Hydrazine	Room	55 gms. H ₃ BO ₃ per 100 cc N ₂ H ₄	(Welsh and Broderson, 1915)

Melting point data are given for the following systems:

H ₃ BO ₃ + Glucose	(No compounds)	
H ₃ BO ₃ + Galactose	(")	Mehta and Kantak (1946)
H ₃ BO ₃ + Tartaric Acid	(")	
H ₃ BO ₃ + Resacetophenone	(4:1 compound)	
H ₃ BO ₃ + Gallacetophenone	(4:1 ")	Neelakantam, Narayanan, and Sitaraman (1947).
H ₃ BO ₃ + Resorcylic Aldehyde	(3:1 ")	
H ₃ BO ₃ + 2 Acetyl - 1 Naphthol	(3:1 ")	

0 BORIC ACID (Tetra) H₂B₄O₇

100 grams water dissolve 2.69 grams H₂B₄O₇ at 15°, Sp. Gr. = 1.015. (Gerlach, 1889.)

BARIUM Ba

The solubility of barium in molten BaBr_2 and BaCl_2 and vice versa has been investigated by Cubicciotti and Thurmond, 1949 and Eastman, Cubicciotti, and Thurmond, 1950. The eutectics are as follows:

	Eutectic 1		Eutectic 2	
	t°	mole % Ba	t°	mole % Ba
Ba + BaBr_2	790	14	700	94
Ba + BaCl_2	840	40	688	95

BARIUM ALUMINATES $x\text{BaO} \cdot y\text{Al}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

AlO

THE SYSTEM BARIUM OXIDE - ALUMINUM OXIDE - WATER

Malquori (1926) and Carlson, Chaconas and Wells (1950) agree on the nature of some of the saturating phases, but the shapes of their isotherms differ. The latter investigators studied the metastable equilibrium in considerable detail.

Results of Malquori, 1926 at 20°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
BaO	Al_2O_3		BaO	Al_2O_3	
0.0100	0.0020	$\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$	1.873	0.456	$\text{Al}_2\text{O}_3 \cdot \text{BaO} \cdot 6\text{H}_2\text{O}$
0.5187	0.0373	"	2.134	0.630	" + $\text{Al}_2\text{O}_3 \cdot 2\text{BaO} \cdot 5\text{H}_2\text{O}$
0.9016	0.1179	"	2.211	0.641	$\text{Al}_2\text{O}_3 \cdot 2\text{BaO} \cdot 5\text{H}_2\text{O}$
1.205	0.2105	" + $\text{Al}_2\text{O}_3 \cdot \text{BaO} \cdot 6\text{H}_2\text{O}$	3.511	0.671	" + $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
1.330	0.279	$\text{Al}_2\text{O}_3 \cdot \text{BaO} \cdot 6\text{H}_2\text{O}$	3.450	0.430	$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
1.654	0.345	"	3.390	0.002	"
1.732	0.378	"	3.320	0.001	"

Results of Carlson, Chaconas and Wells, 1950 at 30°

The stable phases are $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, $2\text{BaO} \cdot \text{Al}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ and $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$. The authors point out that the region of stability of 2.1.5 is small (52-55.5 g/l BaO, 2.8-2.8 g/l Al_2O_3), if indeed it is the stable phase. The solubilities of Gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), 2.1.5, and 1.1.4 are very similar in these solutions, and the data do not preclude one of the other solids being stable in this region.

Ba BARIUM

Equilibria involving stable phases

Gms. per liter Sat. Sol.			Solid Phase	Gms. per liter Sat. Sol.		Solid Phase
BaO	Al ₂ O ₃	BaO		Al ₂ O ₃		
4.8	0.20	Al ₂ O ₃ · 3H ₂ O	55.4	3.08*	Al ₂ O ₃ · 3H ₂ O + Ba(OH) ₂ · 8H ₂ O	
9.7	0.39	"	32.4	5.20*	2BaO · Al ₂ O ₃ · 5H ₂ O	
14.2	0.70	"	37.8	4.20*	"	
19.0	0.88	"	43.6	3.35*	"	
23.9	1.06	"	48.1	2.95*	"	
29.1	1.40	"	52.0	2.80	" + Al ₂ O ₃ · 3H ₂ O	
34.2	1.69	"	53.7	2.75	2BaO · Al ₂ O ₃ · 5H ₂ O	
38.8	2.00	"	55.4	2.70	" + Ba(OH) ₂ · 8H ₂ O	
44.7	2.56	"	54.1	1.42	Ba(OH) ₂ · 8H ₂ O	
49.6	2.69	"	52.9	0.0	"	

Wholly metastable equilibria

Gms. per liter sat. sol.		Gms. per liter sat. sol.		gms. per liter sat. sol.	
BaO	Al ₂ O ₃	BaO	Al ₂ O ₃	BaO	Al ₂ O ₃
Solid Phase BaO·Al ₂ O ₃ ·4H ₂ O		Solid Phase BaO·Al ₂ O ₃ ·7H ₂ O		Solid 1:1:7 Contd.	
12.5	5.00*	20.0	7.44*	49.2	7.32*
17.6	2.83*	22.8	7.42*	50.3	7.10*
22.0	2.79*	25.6	6.89*	54.2	7.16*
26.4	2.90*	27.8	7.12*	55.3	7.78*
31.6	2.74*	30.7	7.48*	57.7	7.65*
33.3	3.11*	33.3	7.20*	62.2	7.80*
35.2	3.08*	34.4	7.33*		
37.5	3.25*	36.6	7.24*	Solid 7BaO·6Al ₂ O ₃ ·36H ₂ O	
40.7	2.68*	37.3	7.20*	29.5	11.80*
43.2	3.33*	41.4	7.45*	35.2	12.20*
45.4	2.74*	41.9	7.10*	42.1	11.14*
49.9	2.74*	43.6	7.16*	46.4	11.60*
55.6	2.86*	46.3	6.95*	52.7	11.00*
				56.5	9.90*
				66.1	10.20*

* = metastable. ^a = Solid Ba(OH)₂·8H₂O also present.

A60 BARIUM ARSENITES $x\text{BaO} \cdot y\text{As}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

THE SYSTEM $\text{BaO} - \text{As}_2\text{O}_3 - \text{H}_2\text{O}$
(Story and Anderson, 1924)

Data are given for the composition ($\text{As}_2\text{O}_3:\text{BaO}$ mole ratio) of the solid phase in equilibrium with various concentrations of As_2O_3 in solution at 25° and 50°, but the BaO concentration in the liquid is not reported.

Gms. As_2O_3 per 100 ml sat. sol.		Solid Phase
25°	50°	
< 0.04	< 0.16	$\text{Ba}(\text{OH})_2$
0.04-0.6	0.16-0.65	$\text{Ba}(\text{OH})\text{AsO}_2 \cdot 2\text{H}_2\text{O}$
0.6-2.2	0.65-3.9	$2\text{BaO} \cdot 3\text{As}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$
> 2.2	> 3.9	As_2O_3

BARIUM ARSENATES $x\text{BaO} \cdot y\text{As}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

AsO

EQUILIBRIUM IN THE SYSTEM BARIUM OXIDE - ARSENIC PENTOXIDE - WATER

This system was first studied by Hendricks (1926) at 30°. He reported the existence of the compounds: $3\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ ($\text{Ba}_3(\text{AsO}_4)_2 \cdot x\text{H}_2\text{O}$), $2\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ ($\text{Ba}_2\text{HAsO}_4 \cdot \text{H}_2\text{O}$), and $\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$ ($\text{BaH}_4(\text{AsO}_4)_2 \cdot 2\text{H}_2\text{O}$). The solid phases were identified by wet residue analysis and microscopic examination, but the analytical results presented do not justify assigning the formula $\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$ to the third solid.

Guerin (1938) reports five compounds at 17°: $3\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, $2\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, $\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ ($\text{BaH}_4(\text{AsO}_4)_2 \cdot \text{H}_2\text{O}$), $\text{BaO} \cdot \text{As}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ ($\text{BaH}_4(\text{AsO}_4)_2$), and $\text{BaO} \cdot 2\text{As}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ ($\text{Ba}(\text{As}_2\text{O}_7\text{H}_3)_2$). Thus he agrees on the existence of the 3:1:x and 2:1:3 compounds, finds the 1:1 compound in two hydrated forms (.3 & .2), but not the hydrate found by Hendricks (.4), and finds a new compound 1:2:3. The compositions of the compounds found by Guerin were fixed by wet residue analyses on many mixtures, and the tie lines converge sharply in all cases. Equilibrium was approached from undersaturation by prolonged agitation.

The results of the two authors on the solubilities of the 3:1:x and 2:1:3 compounds agree moderately well in solutions containing less than 20% As_2O_3 by weight, as do the listed compositions of the isothermal invariant point involving hydrated As_2O_3 .

In Guerin's work, the compound 1:1:3 was found to be wholly metastable with respect to the compound 1:2:3. The invariant point 1:1:3 + 1:1:2 + solution coincides with that of the stable 1:1:3 + 1:2:3 + solution and the slope of the 1:1:2 solubility curve differs but slightly from that of the 1:1:3 compound. It is therefore possible that the solubility curve of the 1:1:2 compound is merely the approximate metastable extension of the solubility curve of the 1:1:3, and that the apparent extrapolation of the tie lines to the composition 1:1:2 is coincidental and caused by lack of equilibrium along the curve, evaporation of water during sampling of wet residues, etc.

8a BARIUM

Data of Guerin, 1938 at 17°

Gms. per 100 gms. sat. sol.		Density	pH	Solid Phase
As ₂ O ₅	BaO	Sat. Sol.		
0.0	2.92	1.038		Ba(OH) ₂ ·8H ₂ O
...	2.895	1.037		3:1:x
...	2.91	1.039		"
...	2.61	1.030		"
...	1.98	1.022		"
...	1.92	1.024		"
...	1.60	1.019		"
...	0.66	1.004		"
0.001	.375	1.002		"
.006	.013	1.0	9.2	"
As ₂ O ₃ .006	.012	1.0	9.2	"
(Ave.) .025	.031	1.0	8.4	3:1:x + 2:1:3
.033	.035	...	8.4	2:1:3
.053	.050	...	6.3	"
.156	.111	...	5.8	"
.296	.218	...	5.2	"
1.24	.75	1.021	4.6	"
2.32	3.72	1.051	3.6	"
6.78	4.08	1.094	3.0	"
12.27	7.20	1.208	2.8	"
13.66	7.82	1.230	2.7	"
15.13	8.32	1.255	2.5	"
19.08	10.71	1.353	2.3	"
23.63	12.53	1.441	2.0	"
24.44	13.12	1.450	2.0	"
25.14	13.53	1.481	1.9	"
27.60	12.59	1.502	1.5	1:1:3
30.28	11.68	1.554	1.4	"
33.59	11.27	1.576	1.2	"
38.41	10.56	1.636		"
42.01	9.93	1.691		"
43.80	9.48	1.725		"
45.10	9.32	1.750		"
46.04	9.23	1.762		1:1:2-Metastable (1:1:3 ?)
46.63	8.89	1.772		" " "
47.60	8.87	1.802		" " "
52.05	7.45	1.850		" " "
56.07	6.03	1.904		" " "
57.88	5.42	1.941		" " "
59.70	4.80	1.970		" " "
61.52	4.15	1.984		" " "
66.56	2.65	2.077		" " "
46.02	8.82	1.765		1:2:3
46.15	4.30	1.605		"
46.90	2.15	1.572		"
50.48	0.35	1.602		"
55.71	.15	1.734		"
59.38	.13	1.819		"
61.36	Traces	1.868		"
67.84	...	2.061		"
71.72	...	2.172		"
72.96	...	2.181		As ₂ O ₅ ·4H ₂ O
3:1:x = Ba ₃ (AsO ₄) ₂ ·xH ₂ O 2:1:3 = BaHAsO ₄ ·H ₂ O 1:1:3 = BaH ₄ (AsO ₄) ₂ ·2H ₂ O				
1:1:2 = BaH ₄ (AsO ₄) ₂ 1:2:3 = Ba(As ₂ O ₇ H ₃) ₂				

Data of Hendricks, 1926 at 30°

Gms. per 100 gms. sat. sol.		Mol. ratio in solution	d ₂₀ of sat. solution	Solid Phase
BaO	As ₂ O ₅			
0.22	0.002	136.8	1.003	Probably solid solution
0.11	0.003	57.3	1.002	"
0.02-0.03	0.29-0.034	0.93-1.37	1.001	BaHAsO ₄ ·H ₂ O + Ba ₂ (AsO ₄) ₂ ·xH ₂ O
2.63	3.98	0.99	1.067	BaHAsO ₄ ·H ₂ O
3.60	5.86	0.92	1.094	"
4.36	7.26	0.90	1.117	"
4.04	6.72	0.90	1.108	"
5.49	9.28	0.89	1.151	"
6.25	10.56	0.89	1.176	"
6.62	11.27	0.88	1.188	"
6.98	11.12	0.94	1.281	"
9.46	14.92	0.95	1.271	"
11.67	18.52	0.94	1.357	"
13.59	22.95	0.90	1.474	"
15.37	27.26	0.85	1.592	"
16.65	28.01	...	...	" + BaH ₄ (AsO ₄) ₂ ·2H ₂ O
15.65	31.17	0.75	1.694	BaH ₄ (AsO ₄) ₂ ·2H ₂ O
13.35	35.87	0.56	1.719	"
7.53	47.27	0.24	1.809	"
6.56	48.48	0.20	1.817	"
trace	68.40	...	2.150	"
"	72.04	...	2.280	" + 3As ₂ O ₅ ·5H ₂ O
"	59.44	...	1.869	3As ₂ O ₅ ·5H ₂ O

AsO

SOLUBILITY OF BARIUM ARSENATES IN AQUEOUS SALT SOLUTIONS

Compound	t°	Added salt	Solvent	Gms. Barium arsenate per 100 gms. solvent		
Ba ₃ (AsO ₄) ₂	Room	None	(H ₂ O)	0.055	} Field, 1859	
		NH ₄ OH	10%	0.003		
		NH ₄ Cl	5%	0.195		
Solvent: added salt						
		gms. per 100 cc		Gms. Barium arsenate per 100 cc soln.		
		Normality				
Ba ₃ (AsO ₄) ₂	~17°	NH ₄ Cl	21.4	4	0.81	} Guarin, 1941b
			10.6	2	0.60	
		KCl	14.9	2	0.045	
		NH ₄ NO ₃	56.0	7	2.75	
		NH ₄ C ₂ H ₃ O ₂	15.4	2	0.57	
BaHAsO ₄	~17°	NH ₄ Cl	10.6	2	0.55	
		KCl	14.9	2	0.33	
		NH ₄ C ₂ H ₃ O ₂	15.4	2	0.42	

Ba BARIUM

BO BARIUM BORATES $x\text{BaO} \cdot y\text{B}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

THE SYSTEM $\text{Ba}(\text{OH})_2 - \text{H}_3\text{BO}_3 - \text{H}_2\text{O}$ AT 30°
(Sborgi, 1913)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
B_2O_3	BaO	Solid Phase	B_2O_3	BaO	Solid Phase
3.6	0.04	$\text{H}_3\text{BO}_3 + 1.3.7$	0.3	0.23	1.3.7
3.4	0.04	1.3.7	0.3	0.31	1.37 + 1:1.4
2.5	0.04	"	0.2	0.8	1.1.4
2.0	0.04	"	0.2	1.2	"
1.0	0.05	"	0.24	4.8	"
0.5	0.09	"	0.26	5.8	1.14 + $\text{Ba}(\text{OH})_2$
0.4	0.12	"	0.08	5.3	$\text{Ba}(\text{OH})_2$

1.3.7 = $\text{BaO} \cdot 3\text{B}_2\text{O}_3 \cdot 7\text{H}_2\text{O}$ (Triborate); 1.1.4 = $\text{BaO} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$ (Metaborate).

(The original results were plotted and above figures read from curve.)

The results of Constable and Tugtepe, 1952 do not seem to have been obtained with a pure solid phase.

Melting point data for the system $\text{BaO} - \text{B}_2\text{O}_3$ are given by Guertler, 1904 and Levin and MacMurdie, 1949.

BO BARIUM METHOXY BOROHYDRIDE $\text{Ba}(\text{BOCH}_3)_2$

At 19° 500-800 mg dissolve in 100 ml of tetrahydrofuran, benzene and cyclohexane; slightly less in ethyl ether, butyl ether, and ligroin. (Wiberg and Hartwimmer, 1955.)

Br BARIUM BROMIDE BaBr_2

SOLUBILITY OF BaBr_2 IN WATER

(Etard, 1894; Milikan, 1917; Benrath and Lechner, 1940; Benrath, 1941)

These results are in good agreement. Individual values by Scott and Durhan (1930), Ricci and Freedman (1952), Chlopin and Nikitin (1927), and Tyrrell and Richards (1953) agree at 25° (average: 50.2%), as does Chlopin and Nikitin's value at 0° (48.05%), and Ricci and Freedman's at 10° (48.77%). There are determinations by several investigators which are considerably higher than these. Kremers (1856) (0° to 100°); Millikan (1917) at 25° ; Tyrrell and Richards (1953) (4.5° and 10.4°) and Blidin (1953) (25° and 35°) all report values about 2% higher. Bliden (alone) claims that the stable phase at 25° and 30° is $\text{BaBr}_2 \cdot 4\text{H}_2\text{O}$, but if this is so, then the dihydrate should have a still higher solubility.

Gms. BaBr ₂ per 100 gms. Sat. Sol.					Gms. BaBr ₂ per 100 gms. sat. sol. (Benrath)		
Etard, Benrath & Lechner, etal	Kremers, Tyrrell, etal		Solid Phase	t°		Solid Phase	
-3.9 ...	17.8(M.)	Ice		100	56.9	BaBr ₂ ·H ₂ O	
-14.1 ...	38.2(M.)	"		110	58.3	"	
-21.1 ...	44.6(M.)	"		113	58.6	"	
-22.6 46.6	46.6(M.)	Ice + BaBr ₂ ·2H ₂ O		120	59.4	"	
-20 45.6	...	BaBr ₂ ·2H ₂ O		130	59.9	"	
0 47.5	49.5	"		140	59.4(E.)	"	
4.5 ...	49.9	"		150	61.4	"	Br
10 48.5	50.2	"		160	62.2	"	
20 49.5	51.0	"		170	62.5	"	
25 50.0	51.4	"		195	64.6	"	
30 50.6	52.1	"		210	65.4	"	
35 50.9	51.8(Bliden)	"		225	65.8	"	
40 51.5	51.5	"		250	68.8	"	
50 52.5	54.1	"		260	70.2	"	
60 53.5	55.1	"		270	70.7	"	
70 54.5	56.1	"		280	72.4	"	
75 54.7(B.)	...	"		290	74.8	"	
80 55.5	57.4	"		310	76.6	"	
100 57.8	60.0	"		320	78.2	"	
				337	80.6	"	
				342	81.5	"	
				350.0	83.0	BaBr ₂ ·H ₂ O + BaBr ₂	
				372	84.0	BaBr ₂	
				415	85.0	"	

SOLUBILITY OF BARIUM BROMIDE IN AQUEOUS SOLUTIONS OF HYDROBROMIC ACID

Results at 0° (Chlopin and Nikitin, 1927)				Results at 18° (Chlopin, 1925)		Results at 25° (Chlopin and Nikitin, 1927; Scott and Durham, 1930)	
Gms. per 100 gms. sat. sol.	Gms. per 100 gms. sat. sol.	Gms. per 100 gms. sat. sol.	Gms. per 100 gms. sat. sol.	Gms. per 100 cc. sat. sol.	Gms. per 100 cc. sat. sol.	Gms. per 100 gms. sat. sol.	Gms. per 100 gms. sat. sol.
HBr	BaBr ₂	HBr	BaBr ₂	HBr	BaBr ₂	HBr	BaBr ₂
0.0	48.05	11.00	29.32	0.0	86.67	0.0	50.16
0.965	46.25	14.64	23.42	8.915	52.29	1.15	48.30
1.16	45.96	15.80	21.68	11.742	45.73	2.08	46.80
1.83	44.82	18.35	17.81	13.421	40.79	3.98	43.53
2.28	43.97	20.89	14.21	14.858	33.93	5.35	40.76(S.D.)
2.80	43.05	24.20	9.97	21.026	13.36	6.86	38.77
4.07	40.88	25.68	8.24	25.231	8.91	9.19	34.40(S.D.)
4.63	39.71	32.66	2.15	33.521	2.37	12.81	28.73(S.D.)
10.41	30.17	44.01	0.049				

Chlopin and Nikitin (1927) also give results for equilibrium in the system Barium bromide, Radium bromide, Hydrobromic acid and Water at 0° and at 25°

Ba BARIUM

SOLUBILITY OF BARIUM BROMIDE IN AQUEOUS SOLUTIONS OF BARIUM HYDROXIDE AND VICE VERSA AT 25°. (Milikan, 1917)

Further data at 25° are given by Milikan, 1916.

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	BaO	BaBr ₂		BaO	BaBr ₂	
Br	0.0	51.10	BaBr ₂ ·2H ₂ O	3.71	36.41	BaBr ₂ ·BaO·5H ₂ O + BaO·9H ₂ O
	0.78	50.67	"	3.46	27.91	BaO·9H ₂ O
	0.79	50.65	" + BaBr ₂ ·BaO·5H ₂ O	3.48	25.03	"
	0.91	49.30	BaBr ₂ ·BaO·5H ₂ O	3.41	18.42	"
	2.15	41.71	"	3.53	13.45	"
	2.42	40.47	"	4.05	0.0	"

See page 300 for data on the system BaBr₂ - Ba(BrO₃)₂ - H₂O at 25°.

EQUILIBRIUM IN THE SYSTEM BARIUM BROMIDE - BARIUM CHLORIDE - WATER (Benrath and Lechner, 1940)

x = mols. BaBr₂ per mol. of water free salt mixture.

m = mols. H₂O per mol. of water free salt mixture.

Solution					Solid		
Wt. % BaCl ₂	Wt. % BaBr ₂	x	m	Den- sity	x	m	Composition
Results at 25°							
27.0	0.0	0.0	31.4	1.323			BaCl ₂ ·2H ₂ O
22.8	6.90	17.49	29.4	1.338	3.42	1.97	Solid Solution I
22.4	8.16	20.4	28.6	1.351	1.45	2.24	"
21.7	9.37	23.3	28.3	1.361	1.47	2.17	"
17.86	17.03	40.2	25.3	1.400	2.51	2.12	"
12.95	26.8	59.2	21.9	1.498	4.52	2.34	"
10.44	31.9	68.2	20.4	1.560	9.01	2.47	"
9.55	34.2	71.5	19.46	1.588	14.33	2.46	"
9.12	35.4	73.1	18.92	1.614	28.1	2.20	"
8.35	36.3	75.3	18.94	1.606	31.2	2.20	"
6.17	41.3	82.1	17.65	...	41.2	1.90	"
4.28	44.2	87.8	16.89	1.696	50.6	2.15	"
3.31	46.6	90.8	16.13	1.731	76.4	2.48	"
..	..	91.5	16.00	...	..	..	S.S. I + S.S. II
2.70	47.4	92.5	16.10	1.730	93.0	2.11	Solid Solution II
0.0	50.0	100.0	16.50	1.734	..	..	BaBr ₂ ·2H ₂ O

Results at 50°

Wt. % BaCl ₂	Wt. % BaBr ₂	x	m	Den- sity	x	m	Composition
30.5	0.0	0.0	26.4	1.328	..	..	BaCl ₂ ·2H ₂ O
25.7	7.13	16.29	25.3	1.363	1.05	2.00	Solid Solution I
21.0	15.08	33.5	23.4	1.421	3.73	2.93	"
18.21	20.1	48.6	22.1	1.488	3.77	3.18	"
15.22	25.8	54.3	20.5	1.525	6.72	2.94	"
10.37	35.8	70.8	17.57	1.641	30.0	3.65	"
9.11	38.5	74.8	16.80	1.678	32.8	3.48	"
3.65	48.9	90.4	14.50	1.801	68.7	3.09	"
...	...	95.5	14.30	...	..	..	S.S. I + S.S. II
1.34	51.9	96.5	14.35	1.797	82.2	2.85	Solid Solution II
0.0	52.5	100.0	14.92	1.803	..	..	BaBr ₂ ·2H ₂ O

Results at 75°

33.4	0.0	0.0	23.1	1.422	..	..	BaCl ₂ ·2H ₂ O
31.5	2.89	6.06	22.7	1.437	0.03	2.25	Solid Solution I
29.3	6.34	13.19	22.1	1.457	1.99	2.22	"
26.5	11.09	22.7	21.0	1.489	0.34	2.20	"
25.0	13.46	27.4	20.7	1.505	1.22	2.25	"
21.7	19.03	38.0	19.50	1.552	3.59	2.35	"
19.17	22.6	44.8	19.03	1.562	5.00	2.11	"
17.70	26.2	50.9	18.01	1.611	7.53	2.05	"
16.30	28.7	55.2	17.50	1.635	9.57	2.08	"
15.24	30.7	58.5	17.05	1.661	11.60	2.39	"
12.47	36.1	67.0	15.75	1.718	27.5	3.16	"
11.15	38.8	71.0	15.10	1.757	33.7	3.29	"
9.58	42.3	75.2	14.73	1.772	33.1	2.14	"
7.26	45.3	81.4	14.08	1.818	46.2	2.46	"
6.46	46.8	83.6	13.77	1.843	47.8	2.13	"
6.16	47.9	84.5	13.40	...	59.0	3.38	"
5.00	49.1	87.3	13.51	1.855	57.2	2.74	"
4.36	50.8	89.1	13.01	1.894	85.2	2.15	"
3.95	51.3	90.1	12.98	...	90.2	2.28	S.S. I + S.S. II
1.61	53.5	95.8	13.30	1.889	95.9	2.20	Solid Solution II
0.0	54.7	100.0	13.67	1.890	..	..	BaBr ₂ ·2H ₂ O

Results at 100°

36.7	0.0	0.0	19.93	1.508	..	..	BaCl ₂ ·2H ₂ O
35.3	2.44	4.62	19.49	1.530	0.83	1.89	Solid Solution I
31.2	8.55	16.13	18.79	1.561	2.59	1.87	"
28.2	13.30	24.9	18.04	1.593	6.03	2.65	"
22.7	21.7	40.2	16.97	1.657	9.91	2.54	"
17.69	30.4	54.7	15.40	1.752	14.08	1.97	"
11.74	40.7	70.8	13.67	1.860	27.4	2.52	"
7.47	48.8	81.1	12.17	1.968	56.7	3.03	"
6.46	50.3	84.5	12.00	1.977	51.7	2.60	"
...	...	92.5	11.60	...	..	..	S.S. I + S.S. II
2.26	55.3	94.5	11.97	2.016	93.5	2.45	Solid Solution II
0.0	56.9	100.0	12.53	1.998	..	..	BaBr ₂ ·2H ₂ O

Ba BARIUM

THE SYSTEM BARIUM BROMIDE - BARIUM CHLORATE - WATER (Ricci and Freedman, 1952)

at 10°				at 25°			
Gms. per 100 gms. sat. sol.		den- sity	Solid Phase	Gms. per 100 gms. sat. sol.		den- sity	Solid Phase
Ba(ClO ₃) ₂	BaBr ₂			Ba(ClO ₃) ₂	BaBr ₂		
21.22	0.0	1.198	A	27.42	0.0	1.263	A
4.32	46.02	1.724	A + B	5.68	46.53	1.755	A + B
0.0	48.77	1.698	B	0.0	50.07	1.726	B

gr A = Ba(ClO₃)₂·H₂O

B = BaBr₂·2H₂O

THE SYSTEM BARIUM BROMIDE - BARIUM NITRATE - WATER (Ricci and Freedman, 1952)

Gms. per 100 gms. sat. sol.		den- sity	Solid Phase	Gms. per 100 gms. sat. sol.		den- sity	Solid Phase
BaBr ₂	Ba(NO ₃) ₂			BaBr ₂	Ba(NO ₃) ₂		
Results at 10°				Results at 10° contd.			
48.77	0.00	1.698	B	25.38	4.74	1.336	D
47.51	4.80	1.757	B + C*	24.81	4.73	1.321	D
47.47	4.04	1.752	B + D	24.03	4.84	1.319	D + C
47.05	4.04	1.741	D	0.00	6.361	1.051	C
45.79	3.94	1.710	D				
44.41	3.95	1.678	D				
43.68	3.87	1.662	D				
41.47	4.00		D				
38.02	3.98	1.542	D	50.07	0.00	1.726	B
35.14	4.12	1.491	D	48.24	5.21	1.793	B + D
31.68	4.30	1.433	D	47.51	5.23		D
28.04	4.51	1.375	D	46.75	5.20	1.757	D
27.56	4.57	1.367	D	47.23	5.32	1.771	C*
26.99	4.64	1.363	D	46.29	5.15	1.740	C
				0.00	9.246	1.079	C

*metastable

B = BaBr₂·2H₂O C = Ba(NO₃)₂ D = BaBr₂·8Ba(NO₃)₂·12H₂O

THE SYSTEM $\text{BaBr}_2 + \text{Ba}(\text{NO}_3)_2 + \text{Ba}(\text{ClO}_3)_2 + \text{H}_2\text{O}$ AT 10°
(Ricci and Freedman, 1952)

Composition of the invariant solutions

Gms. per 100 gms. sat. sol.			Density	Solid Phases
$\text{Ba}(\text{ClO}_3)_2$	BaBr_2	$\text{Ba}(\text{NO}_3)_2$		
4.50	44.68	3.90	1.779	$\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O} + \text{BaBr}_2 \cdot 2\text{H}_2\text{O} + 1:6:12$
2.0	24.3	4.2	...	$1:8:12 + \text{Ba}(\text{NO}_3)_2 + 1:6:12$
1.60	46.58	3.93	1.762	$1:8:12 + \text{BaBr}_2 \cdot 2\text{H}_2\text{O} + 1:6:12$
4.40	44.71	3.99	1.779	$\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O} + \text{BaBr}_2 \cdot 2\text{H}_2\text{O} + 1:6:12$ Br

$1:6:12 = \text{Ba}(\text{ClO}_3)_2 \cdot 6\text{Ba}(\text{NO}_3)_2 \cdot 12\text{H}_2\text{O}$ $1:8:12 = \text{BaBr}_2 \cdot 8\text{Ba}(\text{NO}_3)_2 \cdot 12\text{H}_2\text{O}$

COMPOSITION OF SOLUTIONS SATURATED WITH BOTH BARIUM
BROMIDE AND BARIUM IODIDE

(Etard, 1894)

t°	Grams per 100 Gms. Solution		t°	Grams per 100 Gms. Solution	
	BaBr_2	BaI_2		BaBr_2	BaI_2
-16	4.8	58.4	170	11.0	67.4
+60	5.5	66.0	210	14.9	67.7
135	9.2	67.2			

Ba BARIUM

THE SYSTEM BARIUM BROMIDE - CADMIUM BROMIDE - WATER
(Benrath and Lechner, 1940)

Br	Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
	CdBr ₂	BaBr ₂	density		CdBr ₂	BaBr ₂	density	
	Results at 25°				Results at 35°			
	52.9	0.0	1.785	Cd ₄	59.2	0.0	1.966	Cd ₄
	49.6	4.21	1.814	"	56.4	3.34	1.991	"
	45.0	11.76	1.878	"	52.7	7.36	2.016	Cd ₀
	41.2	19.31	1.983	"	46.6	17.46	2.038	"
	40.0	25.9	2.040	Cd ₄ + Cd ₀	47.3	15.67	2.060	"
	39.6	26.7	2.165	Cd ₀	40.9	34.9	2.127	"
	38.1	29.4	2.167	"	40.0	25.6	...	"
	37.4	31.5	2.257	"	37.1	31.9	2.260	"
	37.4	32.7	2.295	Cd ₀ + 1:1:4	36.5	34.8	2.344	"
	36.4	34.9	2.312	1:1:4	36.4	35.5	2.379	Cd ₀ + 1:1:4
	36.5	34.6	...	"	36.3	35.4	2.366	1:1:4
	34.4	36.1	2.303	"	33.2	38.0	2.335	1:1:4 + Ba ₂
	31.1	38.7	2.300	"	31.0	39.5	2.321	Ba ₂
	30.2	39.3	2.300	1:1:4 + Ba ₂	25.4	40.9	2.152	"
	30.9	38.2	2.259	Ba ₂	16.49	43.8	1.972	"
	24.6	40.6	2.115	"	15.02	44.5	1.945	"
	14.15	44.1	1.917	"	6.57	48.0	1.831	"
	7.46	46.8	1.803	"	0.0	50.9	1.756	"
	0.0	50.0	1.734	"				
	Results at 30°				Results at 50°			
	56.2	0.0	1.873	Cd ₄	60.8	0.0	1.963	Cd ₀
	49.3	9.53	1.937	"	51.8	9.87	2.017	"
	44.3	18.52	2.056	"	44.6	19.11	2.086	"
	43.4	20.7	2.095	Cd ₄ + Cd ₀	40.8	24.6	2.142	"
	43.5	20.6	2.093	Cd ₀	37.6	31.6	2.289	"
	40.6	24.7	2.132	"	36.6	37.1	2.470	Cd ₀ + 1:1:4
	38.0	29.7	2.205	"	37.0	37.0	2.471	"
	37.3	31.8	2.253	"	36.7	37.3	2.467	1:1:4
	36.6	35.0	2.353	Cd ₀ + 1:1:4	36.1	37.5	2.470	"
	34.9	36.1	2.334	1:1:4	35.6	38.0	2.453	"
	31.5	39.1	2.311	"	34.3	38.8	2.434	"
	30.7	39.3	2.293	1:1:4 + Ba ₂	33.0	39.9	2.421	1:1:4 + Ba ₂
	30.3	39.4	2.277	Ba ₂	31.5	40.2	2.363	Ba ₂
	24.3	40.7	2.118	"	23.7	41.9	2.188	"
	17.68	43.0	1.983	"	15.74	45.0	2.042	"
	8.91	46.6	1.852	"	3.90	50.5	1.867	"
	0.0	50.6	1.745	"	0.0	52.5	1.803	"

(Cont.)

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
CdBr ₂	BaBr ₂	density	Solid Phase	CdBr ₂	BaBr ₂	density	Solid Phase
Results at 75°				Results at 100°			
61.2	0.0	2.047	Cd ₀	61.4	0.0	2.110	Cd ₀
52.4	9.59	2.066	"	56.7	6.55	2.128	"
45.6	18.46	2.127	"	51.9	11.32	2.153	"
40.5	26.7	2.227	"	40.3	28.7	2.326	"
37.9	33.9	2.442	"	38.8	40.1	2.860	Cd ₀ + 1:1:1
37.8	38.9	2.650	Cd ₀ + 1:1:4	38.7	40.6	2.862	1:1:1
37.1	39.6	2.462	1:1:4	37.2	41.0	2.790	1:1:1 + Ba ₂
36.7	40.0	2.639	"	22.2	42.9	2.316	Ba ₂
35.9	40.4	2.637	1:1:4 + Ba ₂	12.26	50.5	2.084	"
34.8	40.7	2.586	Ba ₂	6.59	53.2	2.007	"
22.5	43.9	2.211	"	0.0	56.9	1.999	"
15.82	46.8	2.070	"				
7.42	50.9	1.971	"				
0.0	54.7	1.890	"				
				Cd ₄ = CdBr ₂ ·4H ₂ O			
				Cd ₀ = CdBr ₂			
				Ba ₂ = BaBr ₂ ·2H ₂ O			
				1:1:4 = CdBr ₂ ·BaBr ₂ ·4H ₂ O			
				1:1:1 = CdBr ₂ ·BaBr ₂ ·H ₂ O			

THE SYSTEM BARIUM BROMIDE - MERCURIC BROMIDE - WATER
(Tyrrell and Richards, 1953 (4.5, 10.4, 25°);
Dewaulle and van Heems, 1952 (13°))

At 25° the system is simple: HgBr₂ and BaBr₂·2H₂O are the only saturating phases. Below 25° a new solid phase of variable composition is formed; it seems to be a solid solution within the composition limits BaBr₂·3HgBr₂·8H₂O and BaBr₂·2HgBr₂·7H₂O. Dewaulle and van Heem's data are given only in graphs, but the shape of their curves suggest that the solid is formed at 13° as well as at 4.5° and 10.4° as found by Tyrrell and Richards.

Some further data are given by Hers and Paul, 1913.

sat. sol. wt. %		Wet residue wt. %		sat. sol. wt. %		wet residue wt. %	
HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂
Results at 4.5°				Results at 4.5° cont'd.			
Solid Phase		HgBr ₂		Solid Phase		Solid Solution	
0.270	0.0	...	...	51.7	28.3	66.8	21.0
14.3	8.0	85.4	1.56	51.2	28.7	68.7	20.7
30.1	16.9	79.5	4.97	51.0	29.4	62.8	23.9
45.3	24.2	83.4	7.27	50.0	30.4	58.6	27.0
47.6	25.5	89.2	5.23	50.0	30.1	59.4	26.0
52.4	27.6	82.6	10.0	49.7	31.7	62.0	26.4
				49.7	30.8	62.3	25.4
				49.7	31.6	58.9	27.3

(Cont.)

Ba BARIUM

sat. sol. wt. %		Wet residue wt. %		sat. sol. wt. %		Wet residue wt. %	
HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂	HgBr ₂	BaBr ₂
Results at 4.5° (Cont.)				Results at 10.4° contd.			
Solid Phase		BaBr ₂ ·2H ₂ O		Solid Phase		BaBr ₂ ·2H ₂ O	
49.0	32.1	20.9	64.98	51.8	31.0	6.75	81.4
35.9	35.4	10.9	73.0	32.3	35.8	4.12	82.1
21.9	39.7	9.45	67.9	11.6	44.6	5.09	66.9
10.0	45.0	1.64	82.4	0.0	50.2	...	...
0.0	49.9	...	...		
Results at 10.4°				Results at 25°			
Solid Phase		HgBr ₂		Solid Phase		HgBr ₂	
0.427	0.00	...	...	0.609	0.0	...	...
20.0	10.1	89.6	1.87	15.2	8.64	63.2	8.54
35.4	19.0	84.6	4.62	34.5	19.1	66.0	10.1
48.8	26.1	61.2	19.7	44.7	26.0	49.3	22.9
53.2	28.7	80.4	12.2	50.5	25.4	67.4	17.6
				55.1	29.3	62.2	26.5
				55.0	29.9	69.8	20.2
Solid Phase Solid Solution				Solid Phase BaBr ₂ ·2H ₂ O			
53.0	29.7	60.0	27.5	55.1	29.5	45.2	39.9
53.0	29.6	59.6	27.1	36.0	35.5	15.4	67.1
52.0	30.5	60.5	28.7	16.0	52.7	10.2	60.0
52.0	30.0	58.1	29.8	5.25	47.8	0.0	87.6
52.0	30.5	57.5	29.2	0.0	50.1	...	...
51.9	30.8	56.6	30.2				
51.8	30.6	58.5	29.5				

THE SYSTEM BARIUM BROMIDE - LITHIUM BROMIDE - WATER
(Bliden, 1953)

The author believes his tie-line extrapolations indicate the presence of BaBr₂·4H₂O and of solid solutions of this hydrate with BaBr₂·2H₂O. No other investigators have found the tetrahydrate.

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. wet residue		Solid Phase
BaBr ₂	LiBr	BaBr ₂	LiBr	
Results at 25°				
0.0	64.71	...	...	LiBr·2H ₂ O
...	62.18	41.02	34.22	BaBr ₂ ·2H ₂ O
...	58.36	58.54	21.62	"
...	15.41	77.61	5.47	BaBr ₂ ·2H ₂ O + BaBr ₂ ·4H ₂ O (Solid Soln's.)
2.83	44.78	78.49	5.04	"
6.51	39.54	73.44	6.12	"
14.01	30.48	75.53	4.25	"
22.48	22.42	74.44	3.21	"
33.11	14.43	75.04	4.01	"
41.02	8.13	64.50	3.31	BaBr ₂ ·4H ₂ O
45.38	4.05	66.22	1.48	"
51.48	0.0	...	...	"

(Cont.)

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. wet residue		Solid Phase
BaBr ₂	LiBr	BaBr ₂	LiBr	
Results at 35°				
0.0	66.36	...	...	LiBr ₂ ·2H ₂ O
...	58.89	58.72	19.23	BaBr ₂ ·2H ₂ O
...	52.44	63.08	15.23	"
...	47.56	67.52	11.78	"
2.52	41.02	75.03	6.83	"
3.71	36.71	73.46	6.67	BaBr ₂ ·2H ₂ O + BaBr ₂ ·4H ₂ O (Solid Soln's.)
10.04	30.41	72.52	6.48	"
15.60	25.09	69.71	5.97	"
19.63	22.46	65.67	6.81	"
23.04	19.51	65.12	6.12	"
26.48	16.53	62.53	5.56	"
35.51	10.44	64.05	3.20	BaBr ₂ ·4H ₂ O
38.02	8.07	62.64	2.46	"
43.10	3.68	60.52	2.03	"
51.82	0.0	...	...	"

Br⁺

SOLUBILITY OF BARIUM BROMIDE IN PURE METHYL ALCOHOL ($d_{40}^{22} = 0.7866$).
(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928)

t°	Gms. BaBr ₂ per 100 gms. CH ₃ OH	t°	Gms. BaBr ₂ per 100 gms. CH ₃ OH
0	44.4	30	40.9
10	43.1	40	40.2
15	42.5	50	39.4
20	41.9	60	38.8
		(Crit. Temp.)	(0.4) (Centnerszwer, 1910)

SOLUBILITY IN AQUEOUS METHANOL
(deBruyn, 1892; Richards, 1893; Rohland, 1897)

t°	Gms. BaBr ₂ ·2H ₂ O which will dissolve in 100 gms. aq. CH ₃ OH		
	100%	93.5%	50%
15.0	45.9	27.3	4.0
22.5	56.1	..	..

Ba BARIUM

SOLUBILITY OF BARIUM BROMIDE IN ABSOLUTE ETHYL ALCOHOL (Bonnell and Jones, 1926)

The mixtures were shaken by hand at intervals during a long period of time. Equilibrium was approached from above in some cases. The solutions were analyzed repeatedly until constant results were obtained. Temperatures constant to 0.02°.

t°	Gms. BaBr ₂ per 100 gms. C ₂ H ₅ OH	t°	Gms. BaBr ₂ per 100 gms. C ₂ H ₅ OH	t°	Gms. BaBr ₂ per 100 gms. C ₂ H ₅ OH
0	5.88	20	4.130	50	1.837
10	5.067	30	3.322	60	1.479
Br 15	4.596	40	2.433	70	1.253

SOLUBILITY IN AQUEOUS ETHANOL (deBruyn, 1892; Richards, 1893; Rohland, 1897)

15° - 0.48 gms. BaBr₂·2H₂O dissolve in 100 gms. 97% C₂H₅OH

22.5° - 6 gms. BaBr₂ dissolve in 100 gms. 87% C₂H₅OH

25° - 22.0 gms. BaBr₂ dissolve in 100 ml 97% C₂H₅OH containing 0.2N HBr
(Yagoda, 1930)

SOLUBILITY IN ISOAMYL ALCOHOL

100 cc. of Iso Amyl Alcohol (CH₃)₂CH·(CH₂)₂OH of d₂₅ = 0.805 dissolve 0.013 gm. BaBr₂ at 25°. (Yagoda, 1930.)

SOLUBILITY OF BARIUM BROMIDE IN ACETONE OF THE HIGHEST PURITY (Bell, Rowlands, Bamford, Thomas and Jones, 1930)

t°	Gms. BaBr ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase	t°	Gms. BaBr ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase
0	0.0287	BaBr ₂	30	0.0258	BaBr ₂
10	0.0275	"	40	0.0254	"
20	0.0262	"	50	0.0246	"
25	0.0261	"			

SOLUBILITY OF BaBr₂ IN LIQUID AMMONIA (Linhard and Stephan, 1933, 1934)

100 gms. of a saturated solution at 0° contain to 0.017 gms. BaBr₂.

Melting Point data are given for:

BaBr₂ + LiBr + KBr + NaBr (Kellner, 1917)

BaBr₂ + BaI₂ + SrBr₂ + SrI₂ (Eastman, Melchior and Stickland, 1950)

BaBr₂ + BaF₂ + BaCl₂ (Ruff and Plato, 1903)

BAR IUM PerBROMIDE $BaBr_3$

Br

Data for the formation of barium perbromide in aqueous solutions at 25° are given by Herz and Bulla (1911). See reference calcium perbromide.

BAR IUM BROMATE $Ba(BrO_3)_2$

BrO

SOLUBILITY IN WATER

(Trautz and Anschütz, 1906; Rammelsberg, 1841)

The data of later workers at 25° is in excellent agreement. The solid phase is $Ba(BrO_3)_2 \cdot H_2O$ throughout.

t°	Gms. Ba(BrO ₃) ₂ per 100 Gms. Solution	t°	Gms. Ba(BrO ₃) ₂ per 100 Gms. Solution	t°	Gms. Ba(BrO ₃) ₂ per 100 Gms. Solution
- 0.034	0.28	30	0.95	70	2.922
0	0.286	40	1.31	80	3.521
+10	0.439	50	1.72	90	4.26
20	0.652	60	2.271	98.7	5.256
25	0.788			99.65	5.39

SOLUBILITY OF BARIUM BROMATE IN AQUEOUS SOLUTIONS OF SALTS AT 25°
(Harkins, 1911)

Figures in parentheses show densities of the sat. sols. at $\frac{25^\circ}{4^\circ}$.

Conc. of Salt in Gms. Equivalents per Liter	Gms. $Ba(BrO_3)_2$ Dissolved per Liter in Aqueous Sol. of:		
	KNO_3	$KBrO_3$	$Mg(NO_3)_2$
0	7.93(1.0038)	7.93	7.93
0.025	8.62(1.0059)	5.216(1.0046)	...
0.050	9.91(1.0080)	3.415(1.0062)	...
0.100	10.25(1.0120)	1.72 (1.0109)	8.196(1.0114)

Ba BARIUM

THE SYSTEM BARIUM BROMATE - BARIUM NITRATE - WATER AT 25°

(Harkins, 1911)
(Solid phase $\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$)
Gms. per 100
cc. sat. sol.

(Ricci and Freedman, 1952a)
Gms. per 100
gms. sat. sol.

	Gms. per 100 cc. sat. sol.		Density	Gms. per 100 gms. sat. sol.		Solid Phase
	$\text{Ba}(\text{NO}_3)_2$	$\text{Ba}(\text{BrO}_3)_2$		$\text{Ba}(\text{NO}_3)_2$	$\text{Ba}(\text{BrO}_3)_2$	
	0.0	0.793	...	0.0	0.788	$\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$
	0.327	.722	1.0059	12.71	.395	"
	0.653	.683	1.0083	24.15	.320	"
	1.307	.6415	1.0132	36.19	.257	"
BrO	2.614	.6230	1.0233	44.21	.229	"
				49.92	.220	" + $\text{Ba}(\text{NO}_3)_2$

THE SYSTEM BARIUM BROMATE - BARIUM BROMIDE - WATER AT 25°

(Ricci and Freedman, 1952a)

(Solid Phase $\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$)
Gms. per 100 gms. sat. sol.

	12.71	24.15	36.19	44.21	49.92
BaBr_2					
$\text{Ba}(\text{BrO}_3)_2$	0.395	0.320	0.257	0.229	0.220*

*Solid $\text{BaBr}_2 \cdot 2\text{H}_2\text{O}$ also present.

THE SYSTEM BARIUM BROMATE - BARIUM CHLORIDE - WATER

(Ricci and Freedman, 1952a)

A = $\text{Ba}(\text{BrO}_3)_2 \cdot 2\text{H}_2\text{O}$ B = $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ C = $\text{Ba}(\text{BrO}_3)_2 \cdot \text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
$\text{Ba}(\text{BrO}_3)_2$	BaCl_2	Density	Solid Phase	$\text{Ba}(\text{BrO}_3)_2$	BaCl_2	Density	Solid Phase
Results at 10°				Results at 25°			
0.456	0.0	1.001	A	0.788	0.0	1.003	A
.232	6.57	...	A	.446	5.91	...	A
.201	12.98	...	A	.373	14.21	...	A
.190	18.99	...	A	.338	20.16	...	A
.187	22.34	...	A	.323	23.64	...	A
.185	22.52	1.237	A + C	.321	23.93	1.254	A + C
.161	23.78	1.253	C	.296	24.64	1.265	C
.159	23.92	1.264	C	.266	25.52	1.274	C
.144	24.91	1.267	C + B	.249	26.18	1.283	C
0.0	24.93	1.265	B	.226	27.02	1.294	C + B
				0.0	27.06	1.292	B

THE SYSTEM BARIUM BROMATE - BARIUM CHLORIDE - WATER--Cont.

A = $\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$ B = $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ C = $\text{Ba}(\text{BrO}_3)_2 \cdot \text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Gms. per 100 gms. sat. sol.				Solid Phase	Gms. per 100 gms. sat. sol.				Solid Phase
Ba(BrO ₃) ₂	BaCl ₂	Density	Ba(BrO ₃) ₂		BaCl ₂	Density			
Results at 45°									
1.529	0.0	...	A	0.493	27.20	1.290	C		
0.825	11.94	...	A	.473	27.46	1.291	C		
.658	22.40	...	A	.392	29.60	1.318	C + B BrO		
.623	25.53	1.274	A + C	0.0	29.78	1.321	B		
.560	26.04	1.275	C						

THE SYSTEM BARIUM BROMATE - BARIUM CHLORATE - WATER AT 25°
(Ricci and Smiley, 1944)

Solution			Solid*		
Wt. % $\text{Ba}(\text{BrO}_3)_2$	Wt. % $\text{Ba}(\text{ClO}_3)_2$	Density	Wt. % $\text{Ba}(\text{BrO}_3)_2$	Wt. % $\text{Ba}(\text{ClO}_3)_2$	Composition
0.791	0.0	1.001	100.0	0.0	$\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$
.609	1.292	1.011	95.2	0.26	Solid Solution
.553	2.304	1.016	95.1	.40	"
.491	4.850	1.043	94.9	.61	"
.446	7.019	1.060	92.4	3.1	"
.423	9.370	1.9851	90.2	5.3	"
.402	10.50	1.0951	84.6	10.8	"
.347	14.41	1.1311	78.0	17.3	"
.347	14.56	1.1321	73.5	21.9	"
.310	16.83	1.151	71.5	23.7	"
.282	18.07	1.165	59.2	36.0	"
.249	19.53	1.1781	52.0	43.2	"
.235	20.50	1.186	46.4	48.6	"
.207	21.72	1.202	39.2	55.7	"
.176	22.91	1.2091	32.5	62.4	"
.145	23.85	1.2171	24.0	70.7	"
.112	24.87	1.2271	19.2	75.5	"
.078	25.87	1.242	13.0	81.6	"
.057	26.51	1.2411	5.7	88.8	"
0.0	27.54	1.249	0.0	100.0	$\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O}$

*By extrapolation i = Interpolated value

Ba BARIUM

SOLUBILITY OF BARIUM BROMATE IN POTASSIUM CHLORIDE SOLUTIONS AND IN GLYCINE SOLUTIONS AT 25° (Keefer, Reiber, and Bisson, 1940)

In KCl Solutions Gms. per 1000 gms. H ₂ O		In Glycine Solutions Gms. per 1000 gms. H ₂ O	
KCl	Ba(BrO ₃) ₂	KCl	Ba(BrO ₃) ₂
0.0	7.895	0.0	7.895
1.497	8.395	1.88	8.041
2.996	8.780	3.78	8.182
4.498	9.161	5.67	8.308
6.001	9.499	7.57	8.454
7.507	9.762		

CH BARIUM FORMATE Ba(HCOO)₂

SOLUBILITY OF BARIUM FORMATE IN WATER (Ashton, Houston and Saylor, 1933)

These determinations were made with the greatest possible care and are considered to be more accurate than the previous results of Krasnicki, 1887 and of Stanley, 1904.

t°	Gms. Ba(HCOO) ₂ per 100 gms. H ₂ O	Solid Phase	t°	Gms. Ba(HCOO) ₂ per 100 gms. H ₂ O	Solid Phase
0	26.2	Ba(HCOO) ₂	60	38.6	Ba(HCOO) ₂
10	28.0	"	70	41.3	"
20	29.9	"	80	44.2	"
30	31.9	"	90	47.6	"
50	34.0	"	100	51.3	"
50	36.3	"			

SOLUBILITY OF BARIUM FORMATE IN AQUEOUS SOLUTIONS OF FORMIC ACID AT 25° (Dunn and Phillip, 1934)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HCOOH	Ba(HCOO) ₂		HCOOH	Ba(HCOO) ₂	
0.0	23.51	Ba(HCOO) ₂	23.38	26.09	Ba(HCOO) ₂ ·HCOOH
5.39	24.25	"	28.49	24.71	"
10.57	25.03	"	38.07	23.11	"
15.41	25.72	"	47.5	22.56	"
21.80	26.70	" + Ba(HCOO) ₂ ·HCOOH	58.4	23.45	"
22.43	26.87	Ba(HCOO) ₂ ·HCOO	65.8	25.72	"

The freezing-points of mixtures of Barium Formate and Formic acid are given by Kendall and Adler, 1921.

BARIUM METHIONATE $\text{BaCH}_2(\text{SO}_3)_2$

CH

SOLUBILITY IN WATER AT 25°

Solid phase $\text{BaCH}_2(\text{SO}_3)_2 \cdot 2\text{H}_2\text{O}$:

100 gms. H_2O dissolve 0.368 gm. $\text{BaCH}_2\text{O}_6\text{S}_2$ (rhombohedral plates) }
 100 gms. H_2O dissolve 0.308 gm. $\text{BaCH}_2\text{O}_6\text{S}_2$ (rhombohedral needles) }
 (Backer, 1927; Backer and Terpetra, 1929)

100 gms. H_2O dissolve 0.343 gm. $\text{BaCH}_2\text{O}_6\text{S}_2$ (Valeri and Baumrucker, 1949)

Solid phase $\text{BaCH}_2(\text{SO}_3)_2$:

100 gms. H_2O dissolve 0.410 gms. $\text{BaCH}_2\text{O}_6\text{S}_2$ (Valeri and Baumrucker, 1949)

BARIUM Chlor METHIONATE $\text{BaCHCl}(\text{SO}_3)_2$

CH

100 gms. H_2O dissolve 34.04 gms. $\text{BaCHCl}(\text{SO}_3)_2$ at 25°. (Backer, 1930)

BARIUM MALONATE $\text{BaC}_3\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

CH

SOLUBILITY IN WATER
(Miczynski, 1886)

t°	Gms. $\text{BaC}_3\text{H}_2\text{O}_4$ per 100 Gms.		t°	Gms. $\text{BaC}_3\text{H}_2\text{O}_4$ per 100 Gms.	
	Water	Solution		Water	Solution
0	0.143	0.143	50	0.287	0.285
10	0.179	0.179	60	0.304	0.303
20	0.212	0.211	70	0.317	0.316
30	0.241	0.240	80	0.326	0.325
40	0.266	0.265			

Results slightly higher than the above, from 0°-50° are given by Cantoni and Diotalevi (1905).

Ba BARIUM

CH BARIUM ACETATE $\text{Ba}(\text{CH}_3\text{COO})_2$

SOLUBILITY IN WATER

(Walker and Fyffe, 1903; Krasnicki, 1887, gives incorrect results)

t°	Gms. $\text{Ba}(\text{CH}_3\text{COO})_2$ per 100 Gms.			Solid Phase	t°	Gms. $\text{Ba}(\text{CH}_3\text{COO})_2$ per 100 Gms.			Solid Phase
	Water	Solu- tion				Water	Solu- tion		
0.3	58.8	37.0		$\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$	40.5	79.0	44.1		$\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$
7.9	61.6	38.1		"	41.5	78.7	44.0		"
17.5	69.2	40.9		"	44.5	77.9	43.8		"
21.6	72.8	42.1		"	51.8	76.5	43.4		"
24.1	78.1	43.9		"	63.0	74.6	42.7		"
26.2	76.4	43.3		$\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	73.0	73.5	42.4		"
30.6	75.1	42.9		"	84.0	74.0	42.5		"
35.0	75.8	43.1		"	99.2	74.8	42.8		"
39.6	77.9	43.8		"					

(Transition temperatures 24.7° and 41°)

SOLUBILITY OF BARIUM ACETATE IN AQUEOUS SOLUTIONS OF BARIUM HYDROXIDE AT 25° AND VICE VERSA

(Foote and Hickey, 1937)

Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{CH}_3\text{COO})_2$	
0.0	43.20	$\text{Ba}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
1.35	42.40	"
2.58	41.75	" + $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
2.64	37.97	$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
2.85	29.32	"
3.22	16.91	"
4.489	0.0	"

SOLUBILITY OF BARIUM ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°
(Iwaki, 1914)

Mols. per 100 Mols. Sat. Sol.		Solid Phase	Mols. per 100 Mols. Sat. Sol.		Solid Phase
CH ₃ COOH	(CH ₃ COO) ₂ Ba		CH ₃ COOH	(CH ₃ COO) ₂ Ba	
0	5.18	(CH ₃ COO) ₂ Ba·3H ₂ O	28.72	4.52	3.3.11
0.41	5.21	"	36.54	5.60	"
1.40	5.34	" + 3.3.11	42.08	7.85	"
1.46	5.32	3.3.11	46.51	8.87	" + 1.3
3.30	3.48	"	51.98	8.62	1.3
10.23	3.14	"	65.77	8.40	"
20.60	3.62	"	85.27	7.36	"

CN

3.3.11 = 3(CH₃COO)₂Ba·3CH₃COOH·11H₂O, 1.3 = (CH₃COO)₂Ba·3CH₃COOH.

The composition of the above compound 3.3.11 was confirmed by Dunn and Philip, 1934.

SOLUBILITY OF BARIUM ACETATE IN PURE ACETIC ACID
DETERMINED BY THE FREEZING POINT METHOD
(Davidson and McAllister, 1930)

t°	Gm. Mols. Ba(C ₂ H ₃ O ₂) ₂ per 100 gm. mols. mixture	Solid Phase
16.50	0.0	CH ₃ COOH
15.43	1.59	"
15.0	2.32	"
14.63	3.04	"
19.0	2.67	Ba(C ₂ H ₃ O ₂) ₂ ·3CH ₃ COOH
22.5	3.16	"
31.8	4.48	"
36.0	5.18	"
41.1	6.21	"
47.3	7.53	"
49.0	8.62	"
32.0	6.82	"
48.0	8.11	" (Stable modification)
54.0	8.62	"
64.0	9.84	"
74.1	11.70	"
84.0	14.06	"
90.3	15.58	"
13.8	8.11	"
19.9	9.70	" (Unstable modification)
27.1	11.37	"
32.0	12.38	"

SOLUBILITY OF BARIUM ACETATE IN ALCOHOL SOLUTIONS

100 gms. pure methyl alcohol dissolve 0.55 gm. Ba(C₂H₃O₂)₂ at 15° and 0.23 gm. at the b. pt. (66°). (Henstock, 1934)

100 cc. 97% ethyl alcohol dissolve 0.0723 gm. barium acetate at room temp. (Crowell, 1918)

Ba BARIUM

BARIUM Trifluoro ACETATE $(CF_3COO)_2Ba$

-41.66 gms. $(CF_3COO)_2Ba$ dissolve in 100 gms. CF_3COOH at 29.8° . The solid phase seemed to contain 3.5 moles of solvent per mole of salt. (Hara and Cady, 1954).

-100 parts alcohol dissolve 90 parts $Ba(CF_3COO)_2$ at 20° . (Swarts, 1939).

CH BARIUM Trimethyl ACETATE $Ba[(CH_3)_3C \cdot COO]_2 \cdot 5H_2O$

100 gms. H_2O dissolve 34 gms. of the hydrated salt at 0° , 33 gms. at 20° and 32 gms. at 40° . (Landau, 1893).

BARIUM Sulfo ACETATE $CH_2(SO_3)(CO_2)Ba \cdot H_2O$

100 gms. H_2O dissolve 0.296 gm. $BaC_2H_2O_5S$ at 25° . (Backer, 1927)

BARIUM Brom Sulfo ACETATE $CHBr(SO_3)(CO_2)Ba \cdot 12H_2O$

100 gms. H_2O dissolve 3.14 gms. $CHBr(SO_3)(CO_2)Ba$ at 25° . (Backer, 1927).

BARIUM Chlor Sulfo ACETATE $CHCl(SO_3)(CO_2)Ba \cdot H_2O$

100 gms. H_2O dissolve 1.51 gm. $CHCl(SO_3)(CO_2)Ba$ at 25° . (Backer, 1927).

CH BARIUM MALATE $BaC_4H_4O_5$

SOLUBILITY IN WATER (Cantoni and Basadonna, 1906)

These data do not agree with those of Partheil and Hubner, 1903 and Duboux and Cuttat, 1921, on the next page.

t°	Gms. $BaC_4H_4O_5$ per 100 cc. Sol.	t°	Gms. $BaC_4H_4O_5$ per 100 cc. Sol.	t°	Gms. $BaC_4H_4O_5$ per 100 cc. Sol.
20	0.883	35	0.895	60	1.011
25	0.901	40	0.896	70	1.041
30	0.903	50	0.942	80	1.044

(Cont.)

SOLUBILITY OF ACTIVE AND RACEMIC BARIUM MALATE IN WATER
(Duboux and Cuttat, 1921)

Results for the Active Salt			Results for the Racemic Compound		
t°	Gms. $C_4H_4O_5Ba$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $C_4H_4O_5Ba$ per 100 gms. sat. sol.	Solid Phase
0.0	1.020	$C_4H_4O_5Ba$	0	0.76	$C_8H_8O_{10} \cdot Ba_2 \cdot H_2O$
12.5	1.150	"	-	-	-
25.0	1.240	"	25.0	0.58	"
37.5	1.310	"	37.5	0.84	"

SOLUBILITY IN WATER AND IN ALCOHOL
(Partheil and Hubner, 1903)

100 grams water dissolve 1.24 gms. $BaC_4H_4O_5$ at 18°, and 1.3631 gms. at 25°.

100 grams 95% alcohol dissolve 0.0038 gms. $BaC_4H_4O_5$ at 18°, and 0.0039 gm. at 25°.

BARIUM TARTRATE $Ba(C_2H_2O_3)_2$

CH

SOLUBILITY IN WATER

(Cantoni and Zachoder, 1905; Duboux and Cuttat, 1921;
see also Partheil and Hubner, 1903)

The data of Duboux and Cuttat, in good agreement with these, are listed separately below.

t°	Gms. $Ba(C_2H_2O_3)_2$ per 100 cc. Solution	t°	Gms. $Ba(C_2H_2O_3)_2$ per 100 cc. Solution	t°	Gms. $Ba(C_2H_2O_3)_2$ per 100 cc. Solution
0	0.0205	30	0.0315	70	0.0480
10	0.0242	40	0.0352	80	0.0527
20	0.0279	50	0.0389	85	0.0541
25	0.0297	60	0.0440	..	...

Comparison of Solubility of Active and Racemic Forms in Water

Active Form			Racemate		
t°	Gms. $C_4H_4O_6Ba$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $C_8H_8O_{12}Ba_2$ per 100 gms. sat. sol.	Solid Phase
0	0.0200	$C_4H_4O_6Ba \cdot \frac{1}{2}H_2O$	0	0.0243	$C_8H_8O_{12}Ba_2$
12.5	0.0247	"	12.5	0.0284	"
25.0	0.0294	"	25.0	0.0325	"
37.5	0.0341	"	37.5	0.0366	"

Ba BARIUM

SOLUBILITY OF BARIUM TARTRATE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE, SODIUM CHLORIDE AND AMMONIUM CHLORIDE (Cantoni and Jolkowski, 1907)

The authors refer to their determination of the amount of decomposition of the tartrate by the aqueous chloride solutions. Constant agitation and temperature were maintained.

CH	t°	At Different Temperatures			Varying Concentrations at 16°			
		Gms. Ba(C ₂ H ₂ O ₃) ₂ per 100 cc. Sat. Sol. in:			Gms. Chloride per 100 Gms. Solvent	Gms. Ba(C ₂ H ₂ O ₃) ₂ per 100 cc. Sat. Sol. in:		
		7% KCl	7% NaCl	7% NH ₄ Cl		KCl	NaCl	NH ₄ Cl
	16	0.0823	0.0887	0.1050	0.5	0.0398	0.0410	0.0441
	30	0.1017	0.1151	0.1370	1	0.0466	0.0514	0.0589
	55	0.1230	0.1348	0.1590	3	0.0723	0.0826	0.0892
	70	0.1500	0.1781	0.2030	10	0.1199	0.1260	0.1342
	85	0.1828	0.2168	0.2360	15	0.1435	0.1440	0.1585
					20	0.1466	0.1573	0.1663

SOLUBILITY OF BARIUM TARTRATE IN AQUEOUS ACETIC ACID SOLUTIONS AT 26°-27° (Herz and Muhs, 1903)

Analysis was made by evaporating 50 cc of solution at 70°.

Normality of Acetic Acid	Gms. residue per 50 cc. Sol.	Gms. per 100 cc. Solution	
		CH ₃ COOH	Ba tartrate
0	0.0328	0	0.0655
0.565	0.1151	3.35	0.2300
1.425	0.1559	8.55	0.3115
2.85	0.1739	17.11	0.3475
3.77	0.1866	22.62	0.3728
5.65	0.1865	33.90	0.3726
16.85	0.0218	101.10	0.0436

SOLUBILITY OF BARIUM TARTRATE IN ALCOHOL

100 grams 95% alcohol dissolve 0.032 gm. Ba tartrate at 18° and 0.0356 gm. at 25°. (Partheil and Hubner, 1903).

BARIUM SUCCINATE $\text{BaCH}_2\text{CH}_2(\text{COO})_2$

CH

BARIUM iso SUCCINATE

SOLUBILITY IN WATER
(Miczynski, 1886)

Data in very good agreement with these are given by Partheil and Hubner, 1903, Cantoni and Diotalevi (1905), and Tarugi and Checchi (1901).

t°	Gms. Ba. Succinate per 100 Gms.		Gms. Ba. Iso Succinate per 100 Gms.	
	Water	Solution	Water	Solution
0	0.421	0.420	1.884	1.849
10	0.432	0.430	2.852	2.774
20	0.418	0.417	3.618	3.493
30	0.393	0.392	4.181	4.014
40	0.366	0.365	4.542	4.346
50	0.337	0.336	4.700	4.594
60	0.306	0.305	4.656	4.450
70	0.273	0.272	4.410	4.224
80	0.237	0.237	3.962	3.810

SOLUBILITY OF BARIUM SUCCINATE IN AQUEOUS SOLUTIONS OF
CALCIUM, MAGNESIUM AND SODIUM SUCCINATES AT 25°
(Walker, 1925)

The original results are in terms of gm. mols. of the saturating salt per 1000 gms. H_2O "Corresponding to the weight-molar concentration of the added salt."

In aq. Calcium Succinate Gms. per liter		In aq. Magnesium Succinate Gms. per liter		In aq. Sodium Succinate Gms. per liter	
$\text{Ca}(\text{CH}_2\text{COO})_2$	$\text{Ba}(\text{CH}_2\text{COO})_2$	$\text{Mg}(\text{CH}_2\text{COO})_2$	$\text{Ba}(\text{CH}_2\text{COO})_2$	$\text{Na}(\text{CH}_2\text{COO})_2$	$\text{Ba}(\text{CH}_2\text{COO})_2$
0.00	3.98	1.08	3.54	1.29	3.31
1.25	3.51	2.16	3.28	2.55	2.92
2.49	3.23	4.31	2.93	5.10	2.50
4.98	2.93	6.48	2.70	7.66	2.31
		8.63	2.60		

SOLUBILITY IN ALCOHOL

100 gms. 95% alcohol dissolve 0.0015 gms. Ba Succinate at 18° and 0.0016 gms. at 25°. (Partheil and Hubner, 1903).

Ba BARIUM

CH BARIUM CACODYLATE $\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2$ SOLUBILITY OF BARIUM CACODYLATE IN WATER
(Tiollais, 1936)

t°	Gms. $\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2$ per 100 gms. sat. sol.	Solid Phase
0	46.20	$\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot 9\text{H}_2\text{O}$
8	48.30	"
12.5	49.26	"
15.0	50.24	"
20.0	51.66	"
28.5	55.09	"
32.5	57.32	"
37.0	58.76	"
42.5	61.61	"
47.5	64.55	"
53.0(tr.t)	71.72	" + $\cdot 3\text{H}_2\text{O}$
56.0	71.90	$\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot 3\text{H}_2\text{O}$
61.5	72.90	"
67.0	74.64	"
72.0	76.20	"
77.0	76.62	$\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2$
80.0	76.95	"
82.0	77.24	"
88.0	78.01	"
90.0	78.26	"
94.0	78.60	"
99.0	78.85	"

SOLUBILITY OF BARIUM CACODYLATE IN ALCOHOLS
(Tiollais, 1936)

Solvent	t°	Gms. per 100 gms. sat. sol.	
		$\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2$	$\text{Ba}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot 9\text{H}_2\text{O}$
Methyl alcohol	17	61.46	...
"	18	...	69.82
Ethyl alcohol (95%)	12	41.27	7.75
"	15	44.11	9.32
"	17	46.20	10.65
"	18	...	11.26
" (abs.)	15	42.97	27.03
"	17	...	27.49
"	19	...	28.04

BARIUM PROPIONATE $\text{Ba}(\text{C}_3\text{H}_5\text{O}_2)_2 \cdot \text{H}_2\text{O}$

CH

SOLUBILITY OF BARIUM PROPIONATE IN WATER
(Wing and Thompson, 1926)

The mixtures were constantly stirred for 8 hrs. at the lower temperatures, and for 2-3 hrs. at the higher temperatures. Since barium propionate is hydrolyzed by water in warm solutions the barium was determined as BaSO_4 and the amount of propionate calculated.

The earlier determinations by Krasnioki, 1887, are lower than the above at the lower temperatures and slightly higher at the higher temperatures.

t°	Gms. Ba(C ₃ H ₅ O ₂) ₂ per 100 gms.		Solid Phase	t°	Gms. Ba(C ₃ H ₅ O ₂) ₂ per 100 gms.		Solid Phase
	Sat.				Sat.		
	sol.	Water			sol.	Water	

0.3	36.5	57.5	Ba(C ₃ H ₅ O ₂) ₂ ·H ₂ O	65.3	38.9	63.7	Ba(C ₃ H ₅ O ₂) ₂ ·H ₂ O
5.1	36.2	56.7	"	75.6	39.8	66.1	"
15.0	36.0	56.3	"	80.4	40.2	67.8	"
24.8	36.2	56.7	"	85.6	41.2	70.1	"
34.8	36.6	57.7	"	90.5	42.2	73.0	"
44.8	37.1	59.0	"	95.4	43.2	76.1	"
55.0	38.0	61.3	"	100.7	44.7	82.7	"

SOLUBILITY OF BARIUM PROPIONATE IN ALCOHOL

100 cc 95% ethyl alcohol dissolve 0.1631 gm. $\text{Ba}(\text{C}_3\text{H}_5\text{O}_2)_2$ at room temperature. (Crowell, 1918).

BARIUM Sulfon PROPIONATE (neutral) $\text{BaC}_3\text{H}_5\text{O}_2\text{S} \cdot 4\text{H}_2\text{O}$, *r* and *d*.

CH

100 gms. sat. solution in water contains 6.63 gms. of the anhydrous *r* salt at 24°.6.

100 gms. sat. solution in water contains 2.00 gms. of the anhydrous *d* salt at 24°.6.

(Franchimont and Backer, 1920)

BARIUM α Sulfo PROPIONATE $\text{CH}_3 \cdot \text{CH}(\text{SO}_3)(\text{CO}_2)\text{Ba} \cdot \frac{1}{2}\text{H}_2\text{O}$

CH

100 gms. H_2O dissolve 7.28 gms. $\text{CH}_3\text{CH}(\text{SO}_3)(\text{CO}_2)\text{Ba}$ at 25°. (Backer, 1927).

Ba BARIUM

BARIUM α Brom α Sulfo PROPIONATE $\text{CH}_3\text{CBr}(\text{SO}_3)(\text{CO}_2)\text{Ba}\cdot 3\text{H}_2\text{O}$

100 gms. H_2O dissolve 4.36 gms. $\text{CH}_3\text{CBr}(\text{SO}_3)(\text{CO}_2)\text{Ba}$ at 25° .
(Backer, 1927)

CH BARIUM α Chlor α Sulfo PROPIONATE $\text{CH}_3\text{CCl}(\text{SO}_3)(\text{CO}_2)\text{Ba}\cdot 8\text{H}_2\text{O}$

100 gms. H_2O dissolve 2.88 gms. $\text{CH}_3\text{CCl}(\text{SO}_3)(\text{CO}_2)\text{Ba}$ at 25° .
(Backer, 1927).

BARIUM LACTATE $(\text{CH}_3\text{CHONCOO})_2\text{Ba}$

100 gms. pure methyl alcohol dissolve 1.14 gms. $(\text{CH}_3\text{CHOHCOO})_2\text{Ba}$ at 15° and 1.30 gm. at the b. pt. (66.2°). (Henatock, 1934).

BARIUM CYCLOHEXANOL-2-SULFONATE $(\text{HOCHCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{SO}_3)_2\text{Ba}$

SOLUBILITY IN WATER AT 18°
(Sperling, 1949)

Trans Isomer:

Cis isomer:

17.75 gms. per 100 gms. sat. sol.

8.22 gms. per 100 gms. sat. sol

CH BARIUM β -Methyl ACIPATE (Racemic)

100 gms. sat. solution in water contain 27.6 gms. of the salt at 20° . (Meurisse).

BARIUM n-BUTYRATE $\text{Ba}(\text{CH}_3\cdot(\text{CH}_2)_2\text{COO})_2$

SOLUBILITY OF n-BARIUM BUTYRATE IN WATER
(Wing, 1927)

The solid phase in all cases is the anhydrous salt. These determinations which were made with great care are believed to be more accurate than the previous results of Deszathy, 1893.

t°	Gms. $\text{Ba}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 gms.		t°	Gms. $\text{Ba}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 gms.	
	Sat. Sol.	Water		Sat. Sol.	Water
0.06	27.0	37.0	50.05	26.5	36.1
9.92	26.5	36.1	59.97	27.1	37.2
19.86	26.1	35.4	70.08	28.0	39.0
26.50	25.9	34.9	80.05	29.5	41.7
33.00	25.9	34.9	90.27	31.3	45.5
39.98	26.0	35.2	94.96	32.5	48.1

BARIUM α -Sulfo BUTYRATE $C_2H_5 \cdot CH(SO_3)(CO_2)Ba \cdot 2H_2O$

CH

100 gms. H_2O dissolve 6.04 gms. $C_2H_5 \cdot CH(SO_3)(CO_2)Ba$ at 25° .
(Backer, 1927).

BARIUM n-VALERATE $Ba(C_4H_9 \cdot COO)_2$

SOLUBILITY OF BARIUM n VALERATE IN WATER
(Furth, 1881)

t°	0	20	40	60	70
Gms. $Ba(C_4H_9 \cdot COO)_2$ per 100 gms. H_2O	22	20	20	21	22

BARIUM α -Sulfo VALERATE $C_3H_7 \cdot CH(SO_3)(CO_2)Ba$

100 gms. H_2O dissolve 5.7 gms. $C_3H_7 \cdot CH(SO_3)(CO_2)Ba$ at 25° .
(Backer, 1927).

BARIUM CAMPHORATE $BaC_{10}H_{14}O_4 \cdot 4H_2O$

SOLUBILITY OF BARIUM CAMPHORATE IN AQUEOUS SOLUTIONS
OF CAMPHORIC ACID AT 16° - 17°
(Jungflisch and Landrieu, 1914)

Gms. per 100 Gms. Sat. Sol.

Camphoric Acid	Barium Camphorate	Solid Phase
0.68	0.134	d Camphoric ac. + 1.3
0.84	0.150	"
0.693	0.20	1.3
0.38	2.59	"
0.44	11.10	"
0.48	22.71	"
0.45	32.19	"
0.50	37.22	"
0.51	40.99	1.3 + Ba Camphorate
0	42.59	Ba Camphorate

1.3 = Barium tetracamphorate, $C_{10}H_{14}O_4 \cdot Ba \cdot 3C_{10}H_{16}O_4$.

Ba BARIUM

BARIUM CITRATE $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$

SOLUBILITY IN WATER AND IN ALCOHOL

100 grams water dissolve 0.0406 gram $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$ at 18°, and 0.0572 gm. at 25°.

100 grams 95% alcohol dissolve 0.0044 gram $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$ at 18°, and 0.0058 gm. at 25°. (Partheil and Hubner, 1903).

BARIUM PICRATE $[\text{C}_6\text{H}_2(\text{NO}_2)_3\text{O}]_2\text{Ba} \cdot 5\text{H}_2\text{O}$

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25° (Fischer, 1914, 1918)

Volume per cent $\text{C}_2\text{H}_5\text{OH}$	Gms. $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{O}_2\text{Ba}$ per 100 cc. sat. sol.	Solid Phase
0.0	1.260	$[\text{C}_6\text{H}_2(\text{NO}_2)_3\text{O}]_2\text{Ba} \cdot 5\text{H}_2\text{O}$
10.0	1.037	"
15.0	0.889	"
20.0	0.963	"
25.0	1.260	"
30.0	1.482	"
35.0	1.704	"
40.0	2.149	"
45.0	$\begin{Bmatrix} 1.260 \\ 1.842 \\ 2.340 \end{Bmatrix}$	" + $[\text{C}_6\text{H}_2(\text{NO}_2)_3\text{O}]_2\text{Ba} \cdot 4\text{H}_2\text{O}$
50.0	3.184	$\cdot 5\text{H}_2\text{O} + \cdot 4\text{H}_2\text{O}$
55.0	3.335	"
60.0	3.483	$[\text{C}_6\text{H}_2(\text{NO}_2)_3\text{O}]_2\text{Ba} \cdot 4\text{H}_2\text{O}$
65.0	3.483	"
70.0	3.335	"
75.0	3.261	"
80.0	3.187	"
85.0	3.187	"
90.0	3.113	"
95.0	2.964	"
100.0	5.336	"

At 45.0 per cent alcohol variable results are obtained for the compound containing $5\text{H}_2\text{O}$. Between 40 and 60 per cent alcohol there is a gradual dehydration of the compound and the curve shows a break. The exact position of the intersection of the two curves could not be determined.

BARIUM CAPROATE and BARIUM ISO CAPROATE

CH

SOLUBILITY IN WATER

(Kulisch, 1893) Barium Caproate (Methyl 3 Pentan) $\text{Ba}(\text{CH}_3 \cdot \text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{COO})_2$				(Konig, 1893) Barium Iso Caproate (Methyl 2 Pentan) $\text{Ba}(\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2 \cdot \text{CH}_2\text{COO})_2$			
Gms. $\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2$ per 100 Gms.				Gms. $\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2$ per 100 Gms.			
t°	Water	Solu- tion	Solid Phase	Water	Solu- tion	Solid Phase	
0	11.71	10.49	$\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2 \cdot 3\frac{1}{2}\text{H}_2\text{O}$	14.34	12.54	$\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$	
10	8.38	7.73	"	13.33	11.77	"	
20	6.89	6.45	"	12.67	11.26	"	
30	5.87	5.55	"	12.37	11.01	"	
40	5.79	5.47	"	12.42	11.05	"	
50	6.63	6.21	"	12.83	11.38	"	
60	8.39	7.74	"	13.63	11.90	"	
70	11.09	9.98	"	14.68	12.80	"	
80	14.71	12.82	"	16.24	13.97	"	
90	19.28	16.16	"	17.95	15.23	"	

BARIUM GLUCONATE d $\text{Ba}[\text{CH}_2\text{OH}(\text{CHOH})_4\text{COO}]_2$

100 cc. sat. solution of d Barium Gluconate in Water contain 8.7 gms. $\text{Ba}[\text{CH}_2\text{OH}(\text{CHOH})_4\text{COO}]_2$ at 25°. (May, Weisberg and Herrick, 1920).

BARIUM BENZENE SULFONATE $\text{Ba}(\text{C}_6\text{H}_5\text{SO}_3)_2$

CH

SOLUBILITY IN WATER

20°, 14.35 gms. $\text{Ba}(\text{C}_6\text{H}_5\text{SO}_3)_2$ per 100 cc. sat. sol. (Ephraim and Pfister, 1925, 1925a).

25°, 14.33 gms. $\text{Ba}(\text{C}_6\text{H}_5\text{SO}_3)_2$ per 100 gms. sat. sol. (Solid phase monohydrate). (Dunn and Philip, 1934).

Ba BARIUM

SOLUBILITY OF BARIUM BENZENE SULFONATE IN AQUEOUS SOLUTIONS OF BENZENE SULFONIC ACID AT 25° (Dunn and Philip, 1934)

Gms. per 100 gms. sat. sol.		Solid Phase
$C_6H_5SO_3H$	$Ba[C_6H_5SO_3]_2$	
0.0	14.33	$Ba[C_6H_5SO_3]_2 \cdot H_2O$
9.71	6.20	"
14.60	3.92	"
19.62	2.65	"
28.67	1.10	"
35.96	0.37	"
43.8	0.23	"
50.0	0.12	"

SOLUBILITY IN METHANOL

100 gms. of methyl alcohol dissolve 0.40 gm. barium benzene sulfonate at 15° and 0.40 gms. at the b. pt. (66.0°). (Henstock, 1934).

CH BARIUM Bromo BENZENE SULFONATE $Ba[C_6H_4BrSO_3]_2$

100 gms. H_2O dissolve 3.31 gms. $Ba[C_6H_4BrSO_3]_2$ at 17.5°. (Meyer, 1875).

BARIUM m and p Chloro BENZENE SULFONATES $Ba[C_6H_4ClSO_3]_2$

SOLUBILITY OF EACH IN WATER (Bollinger, 1928)

Results for <u>m</u> (1.5?) $Ba[C_6H_4ClSO_3]_2$		Results for <u>p</u> (1.4) $Ba[C_6H_4ClSO_3]_2$	
t°	Gms. per 100 cc. sat. sol.	t°	Gms. per 100 cc. sat. sol.
18	0.64	18	0.08
98	4.33	98	0.46

BARIUM *p*-iodo BENZENE SULFONATE $\text{Ba}[\text{C}_6\text{H}_4\text{SO}_3\text{I}]_2$

CH

SOLUBILITY OF BARIUM IODO BENZENE SULFONATE IN
 AQUEOUS SOLUTIONS OF SALTS AT 20°
 (Sirucek, 1938)

Salt	Gms. Mols. Salt per liter aq. Solvent	Gm. $\text{Ba}[\text{C}_6\text{H}_4\text{SO}_3\text{I}]_2$ per 100 gms. H_2O
None(=H ₂ O)	0.0	0.8598
KNO ₃	0.01	0.9120
"	0.05	1.0415
"	0.10	1.1579
"	0.50	1.6415
MgCl ₂	0.005	0.9051
"	0.01	0.9369
"	0.025	1.0089
"	0.05	1.0939
KCl	0.01	0.9054
"	0.02	0.9320
"	0.03	0.9614
"	0.05	0.9969
"	0.075	1.0433
"	0.2	1.1754
LaCl	0.00333	0.9748
"	0.00667	1.0394
"	0.01667	1.1490

BARIUM, 3,4 and 2,5 Diiodo BENZENE SULFONATES $\text{Ba}[\text{C}_6\text{H}_3\text{I}_2\text{SO}_3]_2$

100 gms. water dissolve 0.27 gm. of the 3,4 compound at 21.5°.

100 gms. water dissolve 0.522 gm. of the 2,5 compound at 20°.

(Boyle, 1909).

BARIUM 2, 4 DINITRO PHENATE $\text{Ba}[\text{C}_6\text{H}_3(\text{NO}_2)_2\text{O}]_2$

CH

BARIUM 2, 4 DINITRO CRESYLATE $\text{Ba}[\text{C}_6\text{H}_2(\text{CH}_3)(\text{NO}_2)_2\text{O}]_2$

Note:

Pastac and Lecrivain (1948) determined the approximate solubility of the salts by making up mixtures with water in varying proportions, heating until the salt was dissolved, and then cooling to the desired temperature. By noting in which tubes there were no crystals, and those in which there were, the solubility was known within limits.

At 15°, between 0.25 and 0.5 wt. % Barium 2,4-diNitro Cresylate dissolve in water.

At 4°, between 1.0 and 2.0 wt. % Barium 2,4-diNitro Phenate dissolve in water.

At 15°, between 0.5 and 1.0 wt. % Barium 2,4-diNitro Phenate dissolve in water.

Ba BARIUM

CH BARIUM Phenyl SULFATE $(C_6H_5SO_4)_2Ba$

100 gms. sat. solution in alcohol contain 15.0 gms. $(C_6H_5SO_4)_2Ba$ at (hot or cold). (Burkhardt and Lapworth, 1926).

BARIUM BENZOATE $(C_6H_5COO)_2Ba \cdot 2H_2O$

SOLUBILITY OF BARIUM BENZOATE IN WATER

t°	Gms. $(C_6H_5COO)_2Ba$ per 100 cc. sat. sol.	Solid Phase	Authority
15	4.3	$(C_6H_5COO)_2Ba \cdot 2H_2O$	(Tarugi and Checchi, 1901)
18	4.9	"	(Fredholm, 1934)
20	4.96	"	(Ephraim and Pfister, 1925)
100	10.1	" (?)	(Tarugi and Checchi, 1901)

SOLUBILITY OF BARIUM BENZOATE IN WATER AND IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AT 18° (Fredholm, 1934)

Solvent	Gm. Equiv. $Ba(C_6H_5COO)_2$ per liter
Water alone	0.2597 (= 49.2 gms. per liter)
0.1992 NH_4Cl	0.2752
" " + 0.539 NH_3	0.2755
" " + 0.897 "	0.2757

100 gms. methyl alcohol dissolve 0.47 gm. $(C_6H_5COO)_2Ba$ at 15° and 0.60 gm. at the b. pt. (66°). (Henstock, 1934).

CH BARIUM p Brom BENZOATE $(C_6H_4BrCOO)_2Ba \cdot H_2O$

BARIUM p Chlor BENZOATE $(C_6H_4ClCOO)_2Ba \cdot H_2O$

BARIUM p Iodo BENZOATE $(C_6H_4ICOO)_2Ba \cdot H_2O$

100 cc. of 94 percent acetone dissolve 0.007 millimols $(C_6H_4BrCOO)_2Ba$ at room temperature, less than 0.003 millimols of the chloro benzoate, and less than 0.003 millimols of the iodo benzoate. (Bailar, Jr., 1931).

(Also see table top of next page.)

BARIUM p Oxy BENZOATE, etc.

CH

SOLUBILITY OF EACH IN WATER AT 20°
(Ephraim and Pfister, 1925)

Compound	Formula	Gms. Anhydrous compound per 100 cc. sat. sol.
Barium <u>p</u> Chlor Benzoate	$(C_6H_4ClCOO)_2Ba \cdot H_2O$	0.109
" " Oxy "	$(C_6H_4 \cdot OH \cdot COO)_2Ba \cdot 2H_2O$	0.367
" " Methoxy "	$(C_6H_4OCH_3COO)_2Ba \cdot H_2O$	0.0752
" " Nitro "	$(C_6H_4 \cdot NO_2 \cdot COO)_2Ba$	0.127

BARIUM SALICYLATE $Ba(C_6H_4OHCOO)_2 \cdot H_2O$

100 gms. sat. aqueous solution contain 28.65 gms. anhydrous salt at 15° and 54.08 gms. at 100°. (Tarugi and Checchi, 1901).

BARIUM Dinitro SALICYLATE $Ba[C_6H_2(NO_2)_2OHCOO]_2$

CH

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°
(Fischer, 1914, 1918)

The results are not of the highest accuracy since the saturated solutions were not perfectly clear and the determinations were made by evaporating and drying the dissolved compound.

Vol. per cent C_2H_5OH	Gms. $Ba[C_6H_2(NO_2)_2 \cdot OHCOO]_2$ per 100 cc. sat. sol.	Vol. per cent C_2H_5OH	Gms. $Ba[C_6H_2(NO_2)_2 \cdot OHCOO]_2$ per 100 cc. sat. sol.
0.0	0.630	60.0	0.945
10.0	0.524	70.0	0.915
20.0	0.438	80.0	0.894
30.0	0.570	90.0	0.320
40.0	0.794	100.0	0.382
50.0	1.124		

Ba BARIUM

CH BARIUM MANDELATES racemic and active $\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2 \cdot \frac{1}{2}\text{H}_2\text{O}$

SOLUBILITY OF RACEMIC BARIUM MANDELATE IN AQUEOUS SOLUTIONS
OF RACEMIC MANDELIC ACID AT 25°
(Roes and Morrison, 1933)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
$\text{C}_8\text{H}_8\text{O}_3$	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2$	Solid Phase	$\text{C}_8\text{H}_8\text{O}_3$	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2$	Solid Phase
0.0	7.9	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2 \cdot \frac{1}{2}\text{H}_2\text{O}$	9.1	1.3	1:1 Salt
0.3	7.8	"	11.5	1.1	"
1.2	6.4	1:1 Salt	13.4	1.0	"
1.7	4.7	"	14.1	1.0	"
2.0	4.2	"	15.2	1.1	"
3.2	2.6	"	17.0	1.1	"
3.8	2.3	"	17.9	1.1	" + $\text{C}_8\text{H}_8\text{O}_3$
6.6	1.7	"	16.9	0.0	$\text{C}_8\text{H}_8\text{O}_3$
7.8	1.4	"			

1:1 Salt = $\text{Ba}(\text{C}_8\text{H}_7\text{O}_3)_2 \cdot (\text{C}_8\text{H}_8\text{O}_3)_2 \cdot \text{H}_2\text{O}$

SOLUBILITY OF ACTIVE (-) BARIUM MANDELATE IN AQUEOUS SOLUTIONS
OF ACTIVE (-) MANDELIC ACID AT 25°
(Ross, Morrison and Johnstone, 1937)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
$\text{C}_8\text{H}_8\text{O}_3$	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2$	Solid Phase	$\text{C}_8\text{H}_8\text{O}_3$	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2$	Solid Phase
0.0	6.0	$\text{Ba}[\text{C}_8\text{H}_7\text{O}_3]_2 \cdot \frac{1}{2}\text{H}_2\text{O}$	7.8	4.2	Acid Salt
2.0	5.9	"	10.0	3.7	"
3.5	6.2	"	10.9	3.7	" + $\text{C}_8\text{H}_8\text{O}_3$
4.0	6.3	"	10.7	3.2	$\text{C}_8\text{H}_8\text{O}_3$
4.1	6.2	Acid Salt	10.4	2.3	"
5.7	6.2	"	10.1	0.0	"

Acid Salt = $\text{Ba}(\text{C}_8\text{H}_7\text{O}_3)_2 \cdot 2\text{C}_8\text{H}_8\text{O}_3 \cdot \frac{1}{2}\text{H}_2\text{O}$

BARIUM CINNAMATES

CH

SOLUBILITY OF BARIUM CINNAMATES IN WATER, METHYL ALCOHOL AND ACETONE

Compound	Formula	t°	Solvent	Gms. Anhydrous Salt per 100 Gms. Sat. Sol.	Authority
Barium Cinnamate	Ba(C ₉ H ₇ O ₂) ₂ ·2H ₂ O	15	H ₂ O	0.726	(Tarugi and Checchi, 1901)
" "	"	20	"	0.0444*(?)	(Ephraim and Pfister, 1926)
" "	"	100	"	2.27	(Tarugi and Checchi, 1901)
" Allocinnamate	Ba(C ₉ H ₇ O ₂) ₂ ·H ₂ O	19	CH ₃ OH	15.8	(Liebermann, 1903)
" "	"	12	"	15.4	(Michael and Garner, 1903)
" "	Ba(C ₉ H ₇ O ₂) ₂ ·3H ₂ O	20	"	2.56	(Michael, 1901)
" "	"	20	(CH ₃) ₂ CO	0.80	"
" "	"	20	H ₂ O	6	"
" Hydrocinnamate	Ba(C ₉ H ₇ O ₂) ₂ ·2H ₂ O	27	"	2.9	"
" "	"	25	CH ₃ OH	0.1	"
" "	"	16	"	9.7	(Michael and Garner, 1901)
" Isocinnamate	"	20	"	70	(Michael, 1901)
" "	"	20	(CH ₃) ₂ CO	20	"
" "	"	20	H ₂ O	17	"

*gms. per 100 cc. sat. sol.

BARIUM 8-QUINOLINOL-5-SULFONATES C₉H₆ONSO₃Ba

The solubility product constants for both compounds were determined by Nasanen and Vusitalo, 1954 at 25°.

BARIUM 5 and 7-isoQUINOLINE CARBOXYLLATES (C₉H₆NCO₂)₂Ba

CH

Data for the solubility in water at about 25° and 100° are given by Tyson, 1939.

BARIUM β-TRUXILATE BaC₁₈H₁₄O₄·2H₂O

100 cc. sat. solution in water contain 0.028 gm. of the salt at 26°. (de Jong, 1912).

Ba BARIUM

CN BARIUM α -NAPHTHALENE -2- SULFONATE $Ba(C_{10}H_7SO_3)_2$

t°	Solvent	Gms. $Ba(C_{10}H_7SO_3)_2$ per liter
16.5°	Water	3.87* (Ephraim and Pfister, 1925, 1925(a))
18°	"	5.17 (Fredholm, 1934)
	0.0996 N NH_4Cl	6.61 (")
	" + 0.539 N NH_3	6.67 (")
	" + 0.897 N "	6.88 (")

*Solid Phase monohydrated.

SOLUBILITIES IN WATER
OF OTHER BARIUM NAPHTHALENE SULFONATES

Compound	Formula	Gms. anhydrous compd. per 100 cc. t° sat. sol.
Barium naphthalene-5-chloro-1-sulfonate	$Ba(C_{10}H_6ClSO_3)_2 \cdot 2H_2O$	20 0.275(1)
" " 1.4chloro sulfonate	$Ba(C_{10}H_6ClSO_3)_2 \cdot 2H_2O$	18 0.08(2)
" " " " "	"	98 0.48(2)
" " 1.5 " "	"	18 0.64(2)
" " " " "	"	98 4.33(2)
" " -6-oxy-2- "	$Ba(C_{10}H_6 \cdot OH \cdot SO_3)_2 \cdot 6H_2O$	20 1.742(1)
" " -1,5-dinitro-2-oxy-7- "	$Ba(OC_{10}H_4(NO_2)_2SO_3)_2$	17 0.033(5)
" " - " - " -2-ol- "	$Ba(HOC_{10}H_4(NO_2)_2SO_3)_2$	19 0.269(5)

BARIUM NAPHTHYLAMINE SULFONATES

Barium-2-naphthylamine-6-8-disulfonate	$Ba(C_{10}H_7NH_2SO_3)_2$	15	12.0(3)
" " " -5-7 " "	"	15	22.7(3)
" -1- " -2-4-7-trisulfonate	$Ba(C_{10}H_7NH_2(SO_3)_3)$	20	25.0(4)
" " " " "	"	80	257.0(4)

(1) Ephraim and Pfister, 1925, 1925(a); (2) Ferrero and Bolliger, 1928; (3) Braunschweig, 1922, 1925; (4) Friach, 1930; (5) Voloahneva, 1949.

CN BARIUM sodium ETHYLENEDINITRILE TETRACETATE $BaNa_2N_2C_{10}N_{12}O_8 \cdot 8H_2O$

At 30° a saturated solution is 0.17 molar. (Astakhov and Kiseleva, 1950).

BARIUM ANTHRAQUINONE, ANTHRACENE and PHENANTHRENE SULFONATES

CH

SOLUBILITY OF EACH IN WATER

Compound	Formula	t*	Obs. anhydrous salt per 100 cc. sat. sol.
Barium anthraquinone-1-Sulfonate	$\text{Ba}(\text{C}_{14}\text{H}_7\text{O}_2\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	18	0.040(1)
" " " "	"	100	0.100(1)
" " 1.5 Disulfonate	$\text{BaC}_{14}\text{H}_7\text{O}_2(\text{SO}_3)_2 \cdot 2\text{H}_2\text{O}$	18-100	0.048(1)
" " 1.8 " "	$\text{BaC}_{14}\text{H}_7\text{O}_2(\text{SO}_3)_2 \cdot \frac{3}{2}\text{H}_2\text{O}$	18-100	0.028(1)
" " 1.6 " "	$\text{BaC}_{14}\text{H}_7\text{O}_2(\text{SO}_3)_2 \cdot 2\text{H}_2\text{O}$	18	0.066(1)
" " " "	"	100	0.154(1)
" " 1.7 " "	$\text{BaC}_{14}\text{H}_7\text{O}_2(\text{SO}_3)_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	18	0.190(1)
" " " "	"	100	1.111(1)
" " 1.8 Chlor Sulfonate	$\text{Ba}(\text{C}_{14}\text{H}_4\text{O}_2\text{ClSO}_3)_2 \cdot \text{H}_2\text{O}$	18	0.180(1)
" " " "	"	100	1.000(1)
" " 1.5 Nitro Sulfonate	$\text{Ba}(\text{C}_{14}\text{H}_4\text{O}_2\text{NO}_2\text{SO}_3)_2$	20	0.0715(2)
" " 1.8 " "	"	20	0.2478(2)
" Anthracene -1- Sulfonate	$\text{Ba}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	20	0.069(3)
" " -4- " "	"	20	0.0706(6)
" " " "	"	100	0.8128(6)
" " -2- " "	$\text{Ba}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	20	0.0048(3)
" " " "	"	20	0.0196(6)
" " " "	"	100	0.0787(6)
" " 1.5- " "	$\text{BaC}_{14}\text{H}_9\text{S}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$	20	0.3667(6)
" " " "	"	100	0.8480(6)
" " 1.8- " "	"	20	0.0599(6)
" " " "	"	100	0.3170(6)
" " 2,6- " "	$\text{BaC}_{14}\text{H}_9\text{S}_2\text{O}_6 \cdot \text{H}_2\text{O}$	20	0.0657(6)
" " " "	"	100	0.0946(6)
" " 2,7- " "	$\text{BaC}_{14}\text{H}_9\text{S}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$	20	0.9019(6)
" " " "	"	100	6.720(6)
" Phenanthrene -2- " "	$\text{Ba}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot \frac{1}{2}\text{H}_2\text{O}$	20	0.016(4)
" " -3- " "	$\text{Ba}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	20	0.03(4)
" " -10- " "	$\text{Ba}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	20	0.13(4)
" " 10-Chlor-3-or-6-Sulfonate	$\text{Ba}(\text{C}_{14}\text{H}_8\text{ClSO}_3)_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	20	0.01(5)

(1) Fierz-David, Krebaer and Anderan, 1927; these authors give their results in terms of the ccH₂O required to dissolve 1.0 gm. of the hydrated(?) compound. (2) Ullmann and Kertesz, 1919; (3) Ephraim and Pfister, 1925, 1925(a); (4) Sandquist, 1912; (5) Sandquist, 1917, (6) Federov and Lodygin, 1942.

BARIUM HELIANTHATE $(\text{C}_{14}\text{H}_{14}\text{N}_2\text{SO}_3)_2\text{Ba} \cdot 4\text{H}_2\text{O}$

CH

1000 gms. H₂O dissolve 0.201 gm. Barium Helianthate at 20-25°. (Stark and Dehn, 1918).

Ba BARIUM

CH BARIUM STEARATE $[\text{CH}_3(\text{CH}_2)_{16}\text{COO}]_2\text{Ba}$
BARIUM PALMITATE $[\text{CH}_3(\text{CH}_2)_{14}\text{COO}]_2\text{Ba}$
BARIUM MYRISTATE $[\text{CH}_3(\text{CH}_2)_{12}\text{COO}]_2\text{Ba}$
BARIUM LAURATE $[\text{CH}_3(\text{CH}_2)_{10}\text{COO}]_2\text{Ba}$

SOLUBILITY IN VARIOUS SOLVENTS
(Jacobson and Holmes, 1916)

Solvent	t°	Gms. Each Salt (Determined Separately) per 100 Gms. Solvent			
		Ba Stearate	Ba Palmitate	Ba Myristate	Ba Laurate
Water	15.3	0.004	0.004	0.007	0.008
"	50	0.006	0.007	0.010	0.011
Abs. Ethyl Alcohol	16.5	0.006	0.009	0.009	0.010
" "	Room?	...	0.0052*	...	...
" "	50	0.003	0.004	0.004	0.007
Methyl Alcohol	15	0.042	0.045	0.057	0.084
" "	50.5	0.077	0.088	0.108	0.163
Ether	25	0.001	0.001	0.003	0.007
Amyl Alcohol	25	0.007	0.008	0.009	0.009

*(Sträuli, 1918, 1926).

BARIUM HYDNOCARPATE $\text{Ba}[\text{CH}=\text{CH}\cdot\text{CH}_2\cdot\text{CH}_2\text{CH}(\text{CH}_2)_{10}\text{COO}]_2$

BARIUM CHAULMOOGRATE $\text{Ba}[\text{CH}=\text{CH}\cdot\text{CH}_2\cdot\text{CH}_2\text{CH}(\text{CH}_2)_{12}\text{COO}]_2$

SOLUBILITY OF EACH SEPARATELY IN SEVERAL SOLVENTS
(Cole, 1932)

An excess of each compound was shaken with the solvent for one hour at constant temperature and 5 cc. of the sat. solution evap. to dryness.

Solvent	t°	Gms. Hydnocarpate per 100 cc. solvent	Gms. Chaulmoograte per 100 cc. solvent
95% Ethyl Alcohol	15	0.07	0.03
"	30	0.08	0.05
"	b. pt.	0.39	0.34
Ethyl Ether	15	0.03	0.02
"	30	0.04	0.02
"	b. pt.	0.06	0.04
Benzene	15	0.025	0.02
"	30	0.04	0.03
"	b. pt.	0.13	0.07
Petroleum Ether	30	0.022	0.016
(b. pt. 30°-60°)			

BARIUM CYANIDE $\text{Ba}(\text{CN})_2$

CN

SOLUBILITY IN WATER AND IN ALCOHOL AT 14°
(Joannis)

100 parte water dissolve 80 parte $\text{Ba}(\text{CN})_2$.

100 parts 70% alcohol dissolve 18 parts $\text{Ba}(\text{CN})_2$.

BARIUM FERROCYANIDE $\text{Ba}_2\text{Fe}(\text{CN})_6$ BARIUM POTASSIUM FERROCYANIDE $\text{BaK}_2\text{Fe}(\text{CN})_6$

100 parte water dissolve 0.1 part $\text{Ba}_2\text{Fe}(\text{CN})_6 \cdot 6\text{H}_2\text{O}$ at 15°, and 1.0 part at 75°.

100 parts water dissolve 0.33 part $\text{BaK}_2\text{Fe}(\text{CN})_6 \cdot 5\text{H}_2\text{O}$ at ord. temp. (Wyruboff, 1869).

BARIUM THIOCYANATE $\text{Ba}(\text{SCN})_2$

SCN

100 gms. sat. solution in water contains 62.87 gms. $\text{Ba}(\text{SCN})_2$ at 25°. (Cuvelier, 1933). This author also gives results for the system $\text{Ba}(\text{SCN})_2 + \text{Co}(\text{SCN})_2 + \text{H}_2\text{O}$ at 25°.

SOLUBILITY OF BARIUM THIOCYANATE IN AQUEOUS SOLUTIONS OF
BARIUM HYDROXIDE AND VICE VERSA AT 25°
(Foote and Hickey, 1937)

Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{SCN})_2$	
0.0	62.63	$\text{Ba}(\text{SCN})_2 \cdot 3\text{H}_2\text{O}$
2.05	61.97	"
3.17	61.67	" + BaOHSCN
4.75	57.34	BaCHSCN
6.16	54.49	"
8.47	50.94	$\text{BaOHSCN} + \text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
5.89	47.51	$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
3.44	26.54	"
3.58	15.83	"
4.489	0.0	"

Ba BARIUM

SOLUBILITY OF BARIUM THIOCYANATE IN AQUEOUS SOLUTIONS OF
 POTASSIUM THIOCYANATE AND VICE VERSA AT 25°
 (Oocleshaw, 1931)

	Gms. per 100 gms. sat. sol.		Solid Phase
	KSCN	Ba(SCN) ₂	
SCN	0.0	62.61	Ba(SCN) ₂ ·3H ₂ O
	14.45	55.72	"
	19.46	53.14	"
	26.04	46.60	2Ba(SCN) ₂ ·3KSCN·5H ₂ O
	28.95	43.66	"
	34.02	39.45	"
	37.18	37.04	"
	43.92	31.73	"
	45.00	30.75	"
	47.67	28.96	"
	48.28	28.68	" + KSCN
	52.42	22.78	KSCN
	62.32	10.24	"
	70.89	0.0	"

SOLUBILITY OF BARIUM THIOCYANATE IN AQUEOUS SOLUTIONS OF
 AMMONIUM THIOCYANATE AND VICE VERSA AT 25°
 (Oocleshaw, 1934)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NH ₄ SCN	Ba(SCN) ₂		NH ₄ SCN	Ba(SCN) ₂	
0.0	62.61	Ba(SCN) ₂ ·3H ₂ O	31.52	48.43	1:1:1
15.48	55.51	"	31.85	48.33	" + NH ₄ (SCN)
20.75	54.51	"	34.73	41.66	NH ₄ (SCN)
24.70	53.47	"	42.72	28.88	"
24.69	53.65	" + 1:1:1	52.36	15.31	"
23.53	54.61	1:1:1	57.72	8.38	"
25.64	53.37	"	64.33	0.00	"
26.73	52.36	"	m32.19	48.05	NH ₄ (SCN)
27.41	51.63	"	m29.90	52.12	"
28.85	50.36	"	m29.76	52.54	" + Ba(SCN) ₂ ·3H ₂ O
29.52	49.76	"	m28.47	54.08	Ba(SCN) ₂ ·3H ₂ O
29.64	49.68	"	m35.83	53.67	"
30.78	48.96	"	m25.28	53.57	"
31.00	48.52	"			

1:1:1 = Ba(SCN)₂·NH₄SCN·H₂O

m = metastable equilibrium

SOLUBILITY OF BARIUM THIOCYANATE IN AQUEOUS SOLUTIONS OF
SODIUM THIOCYANATE AND VICE VERSA AT 25°
(Occleahaw, 1931)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NaSCN	Ba(SCN) ₂		NaSCN	Ba(SCN) ₂	
0.0	62.61	Ba(SCN) ₂ ·3H ₂ O	46.03	19.77	NaSCN·2H ₂ O
12.96	49.83	"	54.14	7.07	"
19.93	43.53	"	58.78	0.0	"
24.64	39.73	"	m45.09	23.21	NaSCN
31.11	34.93	"	m50.60	15.18	"
39.33	30.94	"	m62.39	0.0	"
41.60	29.99	NaSCN·2H ₂ O			

m = metastable equilibrium.

BARIUM CARBONATE BaCO₃

CO

SOLUBILITY IN WATER

t°	Gms. BaCO ₃ per 1000 gms. H ₂ O	Method	Author
8.8	0.016	Conductivity	(Holleman, Kohlrausch and Rose, 1893)
18	0.022	"	(" ")
	0.056 ?	Polarography	(Heyrovsky and Berezicky, 1929)
24.2	0.024	Conductivity	(Holleman, Kohlrausch and Rose, 1893)
25	0.0180		(Townley, Whitney and Felsing, 1937)
30	0.034	disappearance of solid	(Kernot, d'Agostino and Pellegrino, 1908)
40	0.0241		(Townley, Whitney and Felsing, 1937)

SOLUBILITY OF BARIUM CARBONATE IN WATER CONTAINING CO₂

10° The average of several determinations at about 10°, by Bineau, Lassaigne, Foucroy and Bergmann is 1.10 gms. BaCO₃ per liter water. Wagner gives 7.25 gms. BaCO₃ per liter of water saturated with CO₂ at 4-6 atmospheres pressure.

18° Hachnel, 1924 found the maximum solubility at 18° to occur at 25 atmospheres of CO₂. His data are:

Pressure of Carbon Dioxide	Gms. per 100 gms. sat. sol.	
	Carbonate	Bicarbonate
1.0 atmosphere.....	0.27	0.37
25.0 atmospheres.....	0.59	0.79

(Cont.)

Ba BARIUM

SOLUBILITY OF BARIUM CARBONATE IN WATER CONTAINING CO₂—Cont.

- 25° Eleven determinations by McCoy and Smith (1911), of the solubility of barium carbonate at 25° in water in contact with pressures of CO₂ varying from 0.2 to 30 atmospheres, showed that a maximum solubility is reached at 22 atmospheres (see also calcium carbonate), at which point the saturated solution contains 0.727 mols. = 45.1 gms. H₂CO₃ per liter and 0.028 mols. = 7.3 gms. Ba(HCO₃)₂ per liter. The equilibrium constant is $k = 2.24 \times 10^{-2}$ and the solubility product $Ba^{++} \times CO_3^{--} = k_3 = 8.1 \times 10^{-9}$.

CO

SOLUBILITY OF BARIUM CARBONATE IN AQUEOUS SOLUTIONS OF CHLORIDES FREE OF CARBON DIOXIDE (Townley, Whitney and Felsing, 1937)

Molality of aq. salt	Results at 25° Gm. Mols. BaCO ₃ × 10 ⁻⁴ per 1000 gms.			Results at 40° Gm. Mols. BaCO ₃ × 10 ⁻⁴ per 1000 gms.		
	H ₂ O in aqueous solution of:			H ₂ O in aqueous solution of:		
	LiCl*	NaCl	KCl	LiCl	NaCl	KCl
0.00	0.9114	0.9114	0.9114	1.2217	1.2217	1.2217
0.02	1.345	1.170	1.083	1.670	1.705	1.670
0.05	1.970	1.515	1.330	2.175	2.220	2.075
0.10	2.895	2.030	1.700	2.875	2.810	2.500
0.20	4.325	2.875	2.260	5.060	3.680	3.025
0.30	5.390	3.570	2.685	5.090	4.295	3.355
0.40	6.260	4.180	3.005	6.075	4.655	3.590
0.50	6.980	4.735	3.285	7.015	5.130	3.760
1.00	10.05	6.900	4.160	11.505	6.210	4.190
3.00	24.84	9.950	4.685	29.795	8.615	4.950

*Heyrovsky and Berezicky (1929), using a polarographic method, give the following data which do not agree with those above:

Molarity LiCl solution	0.0	0.001	0.01	0.1
Moles BaCO ₃ dissolved per liter	2.9×10^{-4}	1.8×10^{-4}	1.8×10^{-4}	4.1×10^{-4}

SOLUBILITY OF BARIUM CARBONATE IN AQUEOUS SOLUTIONS OF
POTASSIUM CHLORIDE AND OF SODIUM CHLORIDE
(Cantoni and Goguella, 1905)

Data are also given for solubility in 10% aqueous KCl and NaCl at the boiling point, the time factor being varied from 1 to 198 hours.

In KCl at B.pt. of Sol.		In NaCl at B.pt. of Sol.	
Gms. KCl per 100 Gms. Sol.	Gms. BaCO ₃ per 1000 cc. Sat. Sol.	Gms. NaCl per 100 Gms. Sol.	Gms. BaCO ₃ per 1000 cc. Sat. Sol.
0.15	0.0847	0.15	0.0587
1.00	0.1781	1	0.0787
3	0.2667	3	0.1056
10	0.4274	10	0.1575
30	0.5550	30	0.2784
In 10% KCl Sol.		In 10% NaCl Sol.	
t°	Gms. BaCO ₃ per 1000 cc. Sat. Sol.	t°	Gms. BaCO ₃ per 1000 cc. Sat. Sol.
10	0.2175	10	0.1085
20	0.2408	20	0.1126
40	0.2972	40	0.1231
60	0.3491	40	0.1303
80	0.4049	40	0.1418

THE SYSTEM BARIUM CARBONATE - AMMONIUM CHLORIDE - WATER AT 30°
(Kernot, d'Agostino and Pellegrino, 1908)

Data are also given for 25°. Some uncertainty exists as to the terms in which the results are expressed. In some cases the column headings read "Gms. per liter of H₂O" and in others "Gms. per liter of solution." The saturation was effected by adding just the necessary amount of one constituent to cause the disappearance of the last particle of the other. The amounts so added were determined by weighing the flasks. At high concentrations of the two salts, the sudden increase in solubility appears to indicate a molecular combination.

Cantoni and Goguella, 1905 report that barium carbonate boiled with aqueous NH₄Cl is slowly but completely decomposed. The time required varies inversely as the concentration of the NH₄Cl solution.

Gms. per 1000 cc. H ₂ O		Solid Phase	Gms. per 1000 cc. H ₂ O		Solid Phase
BaCO ₃	NH ₄ Cl		BaCO ₃	NH ₄ Cl	
0.035	0	BaCO ₃	2.245	335.70	BaCO ₃
0.521	8.099	"	2.706	358.66	"
1.333	64.536	"	2.630	418.33	NH ₄ Cl
1.596	92.593	"	2.151	414.71	"
2.000	160.265	"	1.558	413.77	"
2.093	186.775	"	0.730	410.16	"
2.256	268.920	"	0	397.58	"

Ba BARIUM

SIMULTANEOUS SOLUBILITY OF BARIUM CARBONATE AND SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM SALTS (Ramann and Sallinger, 1921)

Barium chloride solutions were added to various mixtures of K_2CO_3 and K_2SO_4 dissolved in water, and the distribution of barium between CO_3 and SO_4 determined at various temperatures and after various lengths of time.

Data for solubility of barium carbonate in aqueous hydroxylamine solutions are given by Hahn and Brunnigasser, 1926.

Data for lowering of the melting point of $BaCO_3$ by Na_2CO_3 are given by Sackur (1911-12).

CO BARIUM OXALATE BaC_2O_4

SOLUBILITY OF THE THREE HYDRATES IN WATER (Groschuff, 1901)

The results of Scholder, Gadenne and Niemann (1937) at 18° and of Money and Davis (1934) at 25° agree. Those of Kohltoff (1908) lie on curves parallel, but lower than these. The discrepancy is great in the case of the $\cdot 1/2$ hydrate and the data are listed separately, below. The data of Cantoni and Diotallevi (1905) and Herz and Muhs (1903) are quite high.

t°	Gms. BaC_2O_4 per 1000 gms. sat. sol.		
	Solid Phase $BaC_2O_4 \cdot 3\frac{1}{2}H_2O$	Solid Phase $BaC_2O_4 \cdot 2H_2O$	Solid Phase $BaC_2O_4 \cdot \frac{1}{2}H_2O$
0	0.058	0.053	0.089
9.5	0.082	...	...
18	0.112 (0.1129)*	0.089 (0.0880)*	0.124 (0.1165)*
25	...	(0.1087)†	...
30	0.170	0.121	0.140
40	...	0.152	0.151
45	...	0.169	...
50	...	...	0.164
55	...	0.212	...
60	...	...	0.175
65	...	0.250	...
73	...	0.285	...
75	...	...	0.188
90	...	...	0.200
100	...	...	0.211

*Scholder, Gadenne and Niemann;

†Money and Davis, 1934.

(Both in gms. BaC_2O_4 per liter of saturated solution.)

SOLUBILITY OF THE THREE HYDRATES IN WATER--Cont.

The following data for the solubility of the above three hydrates in water are given by Kohlrausch, 1908.

$\text{BaC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$		$\text{BaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$		$\text{BaC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$	
t°	Gms. per Liter	t°	Gms. per Liter	t°	Gms. per Liter
2.07	0.0553	3	0.0519	0.08	0.0499
4.2	0.059	5.47	0.0575	2.46	0.053
16.1	0.0962	11.28	0.0693	9.62	0.0619
17.8	0.1047	17.9	0.085	15.04	0.0699
		23.3	0.0987	17.54	0.0751
		28.4	0.1124	27.02	0.091
				33.73	0.1018

CO

SOLUBILITY OF BARIUM OXALATE IN AQUEOUS SOLUTIONS OF OXALIC ACID AT 25°
(Kuraahvili, 1949)

The solid phases were not identified.

Moles $\text{H}_2\text{C}_2\text{O}_4$ per liter solvent	Gms. BaC_2O_4 per liter sat. sol.	Moles $\text{H}_2\text{C}_2\text{O}_4$ per liter solvent	Gms. BaC_2O_4 per liter sat. sol.
0.0	0.131	0.30	0.3927
0.001	0.344	0.60	0.2911
0.010	0.7178	0.63	0.2368
0.100	0.7468	0.79	0.1819
0.150	0.6707		

SOLUBILITY OF BARIUM ACID OXALATE IN WATER
(Groschuff, 1901)

Solid Phase $\text{BaC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.	
	$\text{H}_2\text{C}_2\text{O}_4$	BaC_2O_4		$\text{H}_2\text{C}_2\text{O}_4$	BaC_2O_4
0	0.27	0.030	53	2.92	0.31
18	0.66	0.070	60	3.60	0.40
20.5	0.76	0.076	80	6.21	0.81
38	1.61	0.16	90	7.96	1.11
41	1.82	0.18	99	10.50	1.55

Ba BARIUM

SOLUBILITY OF BARIUM OXALATES IN HYDROCHLORIC ACID SOLUTIONS

Experiments designed to show the solubility of barium acid oxalate in aqueous solutions of hydrochloric acid at 20° are described by Trapp, 1935. Aqueous solutions of barium chloride and oxalic acid were mixed and shaken until equilibrium was reached. The supernatant solution was then analyzed for hydrochloric acid, oxalic acid, and barium. Additional volumes of barium chloride and oxalic acid solution were then added to the original mixture and the operation repeated. The results, plotted in terms of BaO and HCl, show a break in the curve corresponding to a transition from $\text{BaC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ to $\text{BaC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$.

C0 SOLUBILITIES OF BARIUM OXALATE ($\text{BaC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) IN AQUEOUS ACETIC ACID AT 26°-27° (Herz and Muhs, 1903)

BaC_2O_4 was determined by drying at 70°. Note that the (reference) value in pure water does not agree with that of other workers.

Normality of Acetic Acid	Gms. per 100 cc. Solution		Normality of Acetic Acid	Gms. per 100 cc. Solution	
	CH_3COOH	Ba Oxalate		CH_3COOH	Ba Oxalate
0	0.00	0.0154	3.85	23.12	0.1127
0.565	3.39	0.0845	5.79	34.76	0.1021
1.425	8.55	0.1039	17.30	103.90	0.0096
2.85	17.11	0.1111	...	...	...

SOLUBILITY OF BARIUM OXALATE IN AQUEOUS SOLUTIONS OF SALTS AT 25° (Money and Davies, 1938)

Salt	Gms. Mole. Salt per liter aq. solution	Gm. Mols. BaC_2O_4 per liter sat. sol.	Salt	Gm. Mols. Salt per liter aq. solution	Gm. Mols. BaC_2O_4 per liter sat. sol.
None (=H ₂ O)	0.0	0.000483	KNO_3	0.000984	0.000509
KCl	0.00096	0.000496	"	0.00493	0.000558
"	0.00480	0.000563	"	0.00992	0.000643
"	0.00747	0.000588	"	0.04966	0.000938
"	0.00994	0.000616	"	0.100	0.001226
"	0.020	0.000700	MnCl_2	0.0005	0.000698
"	0.050	0.000891	"	0.00225	0.001350
"	0.100	0.001118	"	0.00512	0.002103
"	0.1	0.00180*			
"	0.3	0.00270*			
"	0.5	0.00320*			
"	1.0	0.00390*			

*Kurashvili, 1939 (Soly. in H₂O = 0.00058).

SOLUBILITY OF BARIUM OXALATE IN AQUEOUS SOLUTIONS
OF AMMONIUM OXALATE AT 25°
(Money and Davies, 1934)

Gm. Mols. per liter		Solid Phase
$(\text{NH}_4)_2\text{C}_2\text{O}_4$	BaC_2O_4	
0.00054	0.000393	$\text{BaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
0.00258	0.000070	"
0.00491	0.000050	"

SOLUBILITY OF BARIUM OXALATE IN THE PRESENCE OF SODIUM OXALATE

CO

The equations for the solubility of barium oxalate precipitated in presence of sodium oxalate are deduced by Babko, 1935 and a few experimental results are given.

THE SYSTEM BARIUM OXALATE - URANYL OXALATE - WATER
(Colani, 1934)

Weighed amounts of barium oxalate and uranyl oxalate were added to a given volume of water and the mixtures agitated until attainment of equilibrium. The supernatant solutions were analyzed gravimetrically. This method is not sufficiently accurate for the determination of the solubility of the alkaline earth oxalates but, due to the considerable increase in the solubility of those oxalates by very small quantities of uranyl oxalate, it yields satisfactorily concordant results.

Results at 15°			Results at 50°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{UO}_2\text{C}_2\text{O}_4$	BaC_2O_4		$\text{UO}_2\text{C}_2\text{O}_4$	BaC_2O_4	
0.0221	0.0209	$\text{BaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	0.0461	0.0366	$\text{BaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
0.0432	0.0315	"	0.166	0.102	"
0.0449	0.0306	$\text{Ba}_2\text{UO}_2(\text{C}_2\text{O}_4)_3 \cdot 7\text{H}_2\text{O}$	0.239	0.130	$\text{Ba}_2\text{UO}_2(\text{C}_2\text{O}_4)_3 \cdot 7\text{H}_2\text{O}$
0.0548	0.0353	"	0.368	0.186	"
0.0777	0.0479	"	0.443	0.211	"
0.140	0.0592	$\text{BaUO}_2(\text{C}_2\text{O}_4)_2 \cdot 5\text{H}_2\text{O}$	0.684	0.251	$\text{BaUO}_2(\text{C}_2\text{O}_4)_2 \cdot 5\text{H}_2\text{O}$
0.166	0.0600	"	0.911	0.315	"
0.422	0.0640	"	1.54	0.354	"
0.525	0.0706	"	1.62	0.370	"
0.563	0.0772	"	1.58	0.343	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
0.460	0.0252	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	1.30	0.193	"
0.453	0.0137	"	1.00	0.0	"
0.470	0.0	"			

Ba BARIUM

Cl BARIUM CHLORIDE BaCl_2

SOLUBILITY OF BARIUM CHLORIDE IN WATER

The results of all investigators are in excellent agreement from 0° - 100° . Above 102° (the transition point from $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ to $\text{BaCl}_2 \cdot \text{H}_2\text{O}$) the data of Benrath and Lechner (1940) agrees roughly with that of Engel (1888) and Etard (1894), but the precision is only fair. The data of Eddy and Menzies (1940) are about 1.5% higher.

The values given in the table (0° - 90°) are the averages of Mulder, Engel, 1888; Etard, 1894 [0° to 80° in 10° intervals, also 25°]; Benrath and Lechner, 1940 [25° , 30° , 35° , 50° , 75°]; Eddy and Menzies, 1940 [0° to 90° in 5° intervals]; Schreinemakers, 1909-10, 1910b [30°]; Schreinemakers 1910 [0°]; Schreinemakers and Messinik, 1910 [60°]; Masson, 1911, 1912-13 [30°]; Wolkow, 1926, 1927 [0° , 25°]; Benrath, 1927 [20°]; DiCapua and Bertoni, 1928 [20°]; Benrath and Ammer, 1929 [25°]; Jelissejew, 1926 [0° , 25°]; Findlay and Cruickshank, 1926 [25°]; Bassett, Barton, Foster and Patemann, 1933 [25°]; Foote and Hickey, 1937 [25°]; Taylor, Caley and Evring, 1933 [20°]; Politzsch, 1928, 1929 [25°].

Solid Phase $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Gms. BaCl_2 per t° 100 gms. sat. sol.		Gms. BaCl_2 per t° 100 gms. sat. sol.		Gms. BaCl_2 per t° 100 gms. sat. sol.	
0	23.8	35	28.3	65	32.3
5	24.3	40	28.9	70	33.1
10	25.0	45	29.6	75	33.6
15	25.7	50	30.3	80	34.3
20	26.30	55	30.9	85	35.1
25	27.10	60	31.6	90	35.7
30	27.7				

SOLUBILITY OF BARIUM CHLORIDE IN WATER--Cont.

Results at Higher Temperatures

t°	Gms. BaCl ₂ per 100 gms. sat. sol.			Solid Phase
	(Mulder, Engel, 1888; Etard, 1894)	(Benrath and Lechner, 1940)	(Eddy and Menzies, 1940)	
95	36.5	BaCl ₂ ·2H ₂ O
100	37.0	36.7	37.3	"
102*	37.5	BaCl ₂ ·2H ₂ O + BaCl ₂ ·H ₂ O
105	37.6	BaCl ₂ ·H ₂ O
107	..	37.4	..	"
110	37.9	"
120	..	38.3	38.3	"
130	37.3	..	38.7	"
140	39.3	"
150	..	38.9	39.9	"
160	38.9	..	40.5	"
170	41.2	"
180	..	40.8	41.9	"
200	..	41.2	..	"
215	43.1	..	..	"
230	..	43.1	..	"
250	..	45.9	..	"
270	..	50.1	..	BaCl ₂ ·H ₂ O + BaCl ₂
275	..	50.0	..	BaCl ₂
300	..	49.9	..	"
330	..	49.4	..	"
370	..	0.0	..	"

*Eddy and Menzies (1940) found the transition to occur at 102.1°, Collins and Menzies (1936) report 101.9°.

Ba BARIUM

SOLUBILITY OF BARIUM CHLORIDE IN DEUTERIUM OXIDE (AND WATER)
(Eddy and Menzies, 1940)

Note:

The authors used small closed vessels containing about one gram of solvent. The D_2O had a purity of 99.4%, determined from its freezing point. Including corrections for the volume of water in the vapor phase, the authors estimate the accuracy of each determination at 1%. The experimental results were plotted and the authors read the following rounded values from the curve. The original data are given as mols. of salt per 55.51 mols. of solvent.

Temp. °	Gms. $BaCl_2$ per 100 Gms.		Solid Phase	Temp. °	Gms. $BaCl_2$ per 100 Gms.		Solid Phase
	H_2O	D_2O			H_2O	D_2O	
0	31.2	22.3	$BaCl_2 \cdot 2H_2O$	95	57.5	47.8	$BaCl_2 \cdot 2H_2O$
5	32.3	23.6	"	100	59.4	48.3	"
10	33.5	24.9	"	102.1	60.0	..	$BaCl_2 \cdot H_2O$
15	34.6	26.5	"	105	60.2	49.0	$BaCl_2 \cdot H_2O$
20	35.8	27.7	"	110	60.8	49.5	"
25	37.1	29.1	"	115	61.4	50.0	"
30	38.1	30.3	"	120	62.1	50.6	"
35	39.4	31.9	"	125	62.7	51.2	"
40	40.8	33.2	"	130	63.3	51.7	"
45	42.1	34.5	"	135	63.9	52.3	"
50	43.3	36.0	"	140	64.8	53.0	"
55	44.8	37.3	"	145	65.6	53.8	"
60	46.2	38.6	"	150	66.4	54.5	"
65	47.7	40.1	"	155	67.3	55.3	"
70	49.4	41.4	"	160	68.1	56.1	"
75	50.8	42.7	"	165	68.9	56.8	"
80	52.5	44.0	"	170	70.0	57.7	"
85	54.2	45.5	"	175	71.0	58.5	"
90	55.8	46.9	"	180	72.1	59.4	"
93.3	57.1	47.6	$BaCl_2 \cdot D_2O$				

The transition $BaCl_2 \cdot 2H_2O \rightleftharpoons BaCl_2 \cdot H_2O + H_2O$ was found to occur at 102.1° , and $BaCl_2 \cdot 2D_2O \rightleftharpoons BaCl_2 \cdot D_2O + D_2O$ at 93.3° .

Results in 92% D_2O

100 gms. water containing 92% D_2O (heavy water) dissolve 28.9 gms. $BaCl_2$ at 20° .. (Taylor, Caley, and Eving, 1933).

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

At 0° (Engel, 1888)			At 30° (Masson, 1911, 1912-13; Schreinemakers, 1909-10) (See also Millikan (1918), p. 338)		
Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	HCl	BaCl ₂		HCl	BaCl ₂
1.250	0	24.07	1.3056	0	27.84
1.242	0.32	23.31	1.2651	1.36	24.02
1.228	0.83	22.11	1.2147	3.32	19.20
1.210	1.51	20.14	1.1789	5.01	15.2
1.143	4.58	12.76	1.1419	7.13	11.1
1.118	6.13	9.37	1.1068	10.00	5.8
1.099	7.55	6.33	1.0880	13.43	2.4
1.079	10.81	2.64	1.0895	16.92	0.38
1.088	16.92	0.28	1.1024	20.62	0
			1.1609	32.18	0*

The results of Schreinemakers show that at 37.34% HCl the barium chloride dihydrate is converted into monohydrate.

*Less than 1 part of BaCl₂ is soluble in 20,000 parts of concentrated HCl and in 120,000 parts of conc. HCl containing 1/6 volume of ether. (Mar, 1892).

THE SYSTEM BARIUM CHLORIDE - BARIUM HYDROXIDE - WATER

Results at 25°
(Foote and Hickey, 1937)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ba(OH) ₂	BaCl ₂		Ba(OH) ₂	BaCl ₂	
0.0	27.16	BaCl ₂ ·2H ₂ O	4.12	19.31	BaOHCl·2H ₂ O
0.89	26.94	"			" + Ba(OH) ₂ ·8H ₂ O
1.39	26.83	"	4.06	17.05	Ba(OH) ₂ ·8H ₂ O
1.77	26.72	"	4.05	15.33	"
1.94	26.70	" + BaOHCl·2H ₂ O	4.03	12.62	"
2.65	23.57	BaOHCl·2H ₂ O	4.04	10.10	"
3.13	22.05	"	4.10	6.788	"
3.38	20.79	"	4.224	3.649	"
			4.489	0.0	"

(Cont.)

Ba BARIUM

THE SYSTEM BARIUM CHLORIDE - BARIUM HYDROXIDE - WATER---Cont.

Results at 30° (See also Millikan (1918), below)
(Schreinemakers, 1909-1910, 1910b)

	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	BaCl ₂	BaO		BaCl ₂	BaO	
	27.6	0	BaCl ₂ ·2H ₂ O	18.67	4.61	BaCl(OH)·2H ₂ O
	27.42	1.78	"			+ BaO·9H ₂ O
Cl	27.36	1.77	" + BaCl(OH)·2H ₂ O	18.04	4.62	BaO·9H ₂ O
	24.98	2.33	BaCl(OH)·2H ₂ O	17.08	4.60	"
	21.46	3.27	"	12.81	4.58	"
	19.18	4.67	"	10.77	4.45	"
				0	4.99	"

Results for the system BaCl₂·2H₂O + BaO + Na₂O + H₂O at 30° are given by Schreinemakers, 1910b.

EQUILIBRIUM IN THE SYSTEM BARIUM OXIDE, HYDROCHLORIC
ACID AND WATER AT 30°
(Millikan, 1918)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	HCl	BaO		HCl	BaO	
	0.0	4.99	BaO·9H ₂ O	9.58	21.90	BaCl ₂ ·BaO·5H ₂ O
	3.77	12.38	"			+ BaCl ₂ ·2H ₂ O
	4.49	14.01	"	9.60	21.97	BaCl ₂ ·2H ₂ O
	6.32	17.90	"	9.66	20.32	"
	6.34	17.98	" + BaCl ₂ ·BaO·5H ₂ O	9.66	18.21	"
	6.57	18.40	"	10.48	9.55	"
	6.72	18.79	BaCl ₂ ·BaO·5H ₂ O	12.90	2.83	"
	7.51	19.07	"	18.27	0.16	"
	8.47	20.32	"	32.35	0.0	"
	8.75	20.72	"	37.34	0.0	" + BaCl ₂ ·H ₂ O
				38.63	0.0	BaCl ₂ ·H ₂ O

THE SYSTEM BARIUM CHLORIDE - BARIUM CHLORATE - WATER AT 20°
(BiCapua and Bertoni, 1928)

The results in the authors' printed tables differ from their figures for the solubility of each salt separately in water by an amount which is exactly equal to the water of hydration in each salt. The results have, therefore, been calculated from those in the authors' table, which had evidently been erroneously corrected for water of hydration in BaCl_2 and $\text{Ba}(\text{ClO}_3)_2$.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Cl
$\text{Ba}(\text{ClO}_3)_2$	BaCl_2		$\text{Ba}(\text{ClO}_3)_2$	BaCl_2		
0.0	26.20	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	19.21	19.55	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	
5.51	24.11	"	22.84	17.00	" + $\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O}$	
9.32	24.00	"	24.39	7.69	$\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O}$	
13.03	22.0	"	25.16	0.0	"	
17.48	19.50	"				

THE SYSTEM BARIUM CHLORIDE - BARIUM IODATE - WATER AT 25°
(Ricci, 1951)

Gms. per 100 gms. sat. sol.		Density	Solid Phase	Gms. per 100 gms. sat. sol.		Density	Solid Phase
$\text{Ba}(\text{IO}_3)_2$	BaCl_2			$\text{Ba}(\text{IO}_3)_2$	BaCl_2		
0.0400	0.00	0.997	A	0.0186	23.76	1.245	B
.0189	19.63	1.194	A	(.020)	24.25	1.255	B
.0187	20.50	1.206	A	.0179	24.73	1.258	B
.0198	21.56	1.218	A	.0171	25.45	1.266	B
.0231	25.29 ^m	1.268	A	(.019)	25.51	1.269	B
.0240	25.59 ^m	1.273	A	.0165	26.01	1.274	B
.0267	27.09 ^m	1.286	A + C	.0152	26.82	1.285	B
.0201	22.06	1.223	A + B	.0153	27.11	1.289	B + C
.0189	22.72	1.232	B	.00	27.11	1.289	C

A = $\text{Ba}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$ B = $\text{Ba}(\text{IO}_3)_2 \cdot \text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ C = $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

m = metastable.

Ba BARIUM

THE SYSTEM BARIUM CHLORIDE - BARIUM NITRATE - WATER

Gms. per 100 gms.
sat. sol.

BaCl ₂	Ba(NO ₃) ₂	Solid Phase
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Results at 20°

(Findlay and Cruickshank, 1926)

0.0	8.41	Ba(NO ₃) ₂
7.51	7.17	"
12.31	6.72	"
20.81	6.54	"
25.09	6.93	Ba(NO ₃) ₂ + BaCl ₂ ·2H ₂ O
26.07	1.31	BaCl ₂ ·2H ₂ O
26.32	0.0	"

(Uspenskaya, Glushkova and Bergman, 1955)

0.0	8.50	Ba(NO ₃) ₂
4.64	7.50	"
9.33	6.70	"
14.03	6.50	"
18.76	6.20	"
20.64	6.20	"
21.55	6.30	"
24.60	6.08	BaCl ₂ ·2H ₂ O + Ba(NO ₃) ₂
26.40	2.20	BaCl ₂ ·2H ₂ O
27.00	1.09	"
27.50	0.0	"

Results at 30°

(Coppadoro, 1912, 1913)

6.06	9.55	Ba(NO ₃) ₂
13.75	8.20	"
16.14	7.92	"
22.70	7.94	"
26.11	7.88	Ba(NO ₃) ₂ + BaCl ₂ ·2H ₂ O
26.64	5.37	BaCl ₂ ·2H ₂ O
26.91	4.13	"
27.38	1.58	"

Results at 40°

(Uspenskaya, Glushkova and Bergman, 1955)

0.0	12.50	Ba(NO ₃) ₂
4.47	10.70	"
9.01	9.70	"
13.65	9.00	"
18.28	8.60	"
21.20	8.20	"
21.14	8.10	"
22.95	8.20	"
21.14	8.10	"
22.95	8.20	"
26.00	7.40	BaCl ₂ ·2H ₂ O + Ba(NO ₃) ₂
26.50	5.88	BaCl ₂ ·2H ₂ O
30.50	0.0	"

(Cont.)

THE SYSTEM BARIUM CHLORIDE - BARIUM NITRATE - WATER--Cont.

Results at 60°

(Uspenskaya, Glushkova and Berman, 1955)

Gms. per 100 gms. sat. sol.		Solid Phase
BaCl ₂	Ba(NO ₃) ₂	
0.0	16.17	Ba(NO ₃) ₂
4.30	14.00	"
8.75	12.50	"
13.25	11.70	"
17.80	11.00	"
20.63	10.30	"
22.65	10.20	"
28.20	7.18	BaCl ₂ ·2H ₂ O
29.12	5.67	"
33.50	0.0	"

Cl

Results at 80°, 100°, 120° on a mole basis

(Uspenskaya and Bergman, 1955)

mole% of dissolved salts		moles H ₂ O per mole of dissolved salts in solution			Solid Phase
Ba(NO ₃) ₂	BaCl ₂	80°	100°	120°	
0.0	100.0	21.43	19.71	18.45	BaCl ₂ ·*
16.60	80.40	17.83	...	15.34	"
25.47	74.53	...	13.88	12.88	"
30.04	69.96	17.89	13.50	12.21	Ba(NO ₃) ₂
44.35	55.65	35.59	...	16.74	"
54.48	45.52	42.68	25.68	19.75	"
65.02	34.98	48.98	30.95	22.66	"
76.12	23.88	66.03	35.52	25.66	"
100.0	0.0	66.03	41.30	32.29	"

*at 80°, solid phase is given as BaCl₂·H₂O; at 100°, 120° as BaCl₂.At Various Temperatures

(Etard, 1894)

t°	Gms. per 100 Gms. Sat. Sol.		t°	Gms. per 100 Gms. Sat. Sol.	
	BaCl ₂	Ba(NO ₃) ₂		BaCl ₂	Ba(NO ₃) ₂
Solid Ba(NO ₃) ₂ + BaCl ₂ (·2H ₂ O)					
0	22.5	4.3	100	31	14
20	24.5	6	140	32	20
40	26.5	7.5	180	32	26
60	28.5	9.5	210	32	32

Ba BARIUM

THE SYSTEM BARIUM CHLORIDE - BARIUM NITRATE - WATER--Cont.

At Various Temperatures--Cont.
(Uspenskaya, Glushkova and Bergman, 1955)

t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.	
	BaCl ₂	Ba(NO ₃) ₂		BaCl ₂	Ba(NO ₃) ₂
	Solid: ICE + Ba(NO ₃) ₂			Solid: ICE + BaCl ₂ ·2H ₂ O	
-0.7	0.0	4.75			
-2.1	4.76	4.70			
-3.1	9.50	4.50			
-4.0	14.36	4.30	-7.5	23.50	0.0
-6.5	19.10	4.50			
-7.8	20.94	4.80		Solid: ICE + BaCl ₂ ·2H ₂ O + Ba(NO ₃) ₂	
-8.2	21.85	5.00			
-8.3	23.20	2.30			
-8.2	23.00	1.15	-8.5	22.50	5.10

Data for the aqueous quaternary system BaCl₂ + Ca(NO₃)₂ ⇌ Ba(NO₃)₂ + CaCl₂ at 20°, 40°, 60°, 80° are given by Uspenskaya, Glushkova and Bergman (1955), and at 80°, 100° and 120° by Uspenskaya and Bergman (1955).

THE QUATERNARY SYSTEM BaCl₂ + NaNO₃ + H₂O AT 20° (Findlay and Cruickshank, 1926)

Gms. per 100 gms. sat. solution				Solid Phase
NaCl	NaNO ₃	Ba(NO ₃) ₂	BaCl ₂	
6.57	37.82	1.62	...	NaNO ₃ + Ba(NO ₃) ₂
15.79	24.08	0.14	...	NaCl + Ba(NO ₃) ₂
2.02	...	6.49	22.66	BaCl ₂ ·2H ₂ O + Ba(NO ₃) ₂
14.23	29.75	0.13	...	NaCl + NaNO ₃ + Ba(NO ₃) ₂
*24.16	0.50	7.14	...	BaCl ₂ ·2H ₂ O + NaCl + Ba(NO ₃) ₂

*This solution is incongruently saturated.

Results for this system at 30° are given by Coppadoro, 1913.

EQUILIBRIUM IN THE SYSTEM BARIUM CHLORIDE - BERYLLIUM CHLORIDE - WATER AT 25° (Novoselova, Danilevich, and Tikhonova, 1946)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
BeCl ₂	BaCl ₂		BeCl ₂	BaCl ₂	
0.0	27.17	BaCl ₂ ·2H ₂ O	28.56	Trace	BaCl ₂ ·2H ₂ O
4.92	15.66	"	35.40	"	"
10.27	6.03	"	43.36	"	BaCl ₂ ·2H ₂ O + BeCl ₂ ·4H ₂ O
16.17	1.04	"	43.71	"	" + "
21.15	0.25	"	43.63	0.0	BeCl ₂ ·4H ₂ O

EQUILIBRIUM IN THE SYSTEM BARIUM CHLORIDE - CADMIUM CHLORIDE - WATER
(Benrath and Lechner, 1940)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CdCl ₂	BaCl ₂	Density		CdCl ₂	BaCl ₂	Density	
Results at 25°				Results at 35°—Cont.			
54.9	0.0	1.788	Cd ₂ .5	40.1	10.89	1.707	2:1:5
52.9	3.00	1.815	"	31.7	16.87	1.652	"
52.8	3.38	1.820	" + 2:1:5	26.3	21.5	1.636	" + 1:1:4 Cl
52.5	3.95	1.814	2:1:5	24.0	22.6	1.618	1:1:4
43.2	7.85	1.737	"	21.0	24.2	1.586	"
39.4	9.89	1.706	"	16.60	26.8	1.556	"
33.1	14.25	1.640	"	15.15	27.9	1.550	" + Ba ₂
27.7	18.40	1.606	"	10.44	28.1	1.469	Ba ₂
27.0	18.89	1.602	" + 1:1:4	4.86	28.2	1.383	"
26.2	19.53	1.599	1:1:4	0.0	28.5	1.319	"
24.8	20.0	1.583	"	Results at 50°			
21.3	22.0	1.550	"	57.2	0.0	1.853	Cd·1
18.30	23.5	1.528	"	55.1	3.38	1.890	"
17.27	24.3	1.518	"	54.3	4.86	1.903	" + 2:1:5
13.52	26.6	1.494	"	52.9	5.53	1.883	2:1:5
13.39	26.7	1.495	" + Ba ₂	40.0	12.80	1.750	"
12.56	26.8	1.480	Ba ₂	34.5	16.95	1.719	"
11.56	26.7	1.465	"	27.2	23.2	1.699	"
6.31	27.0	1.386	"	26.1	24.5	1.699	" + 1:1:4
5.35	27.0	1.370	"	24.9	25.3	1.681	1:1:4
0.0	27.0	1.303	"	22.4	26.8	1.670	"
Results at 30°				20.7	27.7	1.660	"
56.2	0.0	1.872	Cd ₂ .5	17.91	29.6	1.639	" + Ba ₂
54.2	3.22	1.859	" + 2:1:5	16.08	29.9	1.604	Ba ₂
51.2	4.36	1.814	2:1:5	5.17	30.1	1.405	"
47.8	6.01	1.770	"	0.0	30.5	1.328	"
36.6	12.62	1.665	"	Results at 75°			
31.4	16.26	1.635	"	58.0	0.0	1.908	Cd·1
26.9	20.0	1.620	" + 1:1:4	55.3	3.90	1.942	"
26.4	20.4	1.618	1:1:4	52.8	7.64	1.986	"
24.1	21.6	1.596	"	52.6	8.53	1.998	" + 2:1:5
20.0	22.6	1.576	"	51.6	9.09	1.994	2:1:5
15.46	26.6	1.527	"	41.1	15.73	1.880	"
14.10	27.4	1.520	" + Ba ₂	30.6	24.4	1.836	"
9.90	27.5	1.449	Ba ₂	27.1	29.2	1.846	"
6.26	27.6	1.396	"	27.1	29.7	1.850	" + 1:1:4
0.0	27.7	1.313	"	26.3	30.0	1.850	1:1:4
Results at 35°				23.9	31.5	1.833	"
57.3	0.0	1.858 ^m	Cd·1	22.7	32.2	1.822	" + Ba ₂
55.2	3.23	1.886 ^m	"	20.5	32.7	1.764	Ba ₂
54.9	3.35	1.877	" + 2:1:5	14.55	32.7	1.628	"
52.3	5.54	1.808	2:1:5	9.57	32.7	1.542	"
				0.0	33.4	1.422	"

m = metastable.

(Cont.)

Ba BARIUM

EQUILIBRIUM IN THE SYSTEM BARIUM CHLORIDE- CADMIUM CHLORIDE- WATER--Cont.

	Gms. per 100 gms. sat. sol.		Density	Solid Phase	Gms. per 100 gms. sat. sol.		Density	Solid Phase
	CdCl ₂	BaCl ₂			CdCl ₂	BaCl ₂		
Results at 100°								
Cl	59.2	0.0	1.993	Cd·1	28.0	34.9	2.066	1:1:3
	56.7	3.47	2.004	"	28.0	35.0	2.065	"
	54.0	6.90	2.028	"	28.9	35.0	2.065	" + Ba2
	50.7	12.44	2.090	" + 2:1:5	22.3	35.1	1.936	Ba2
	46.7	15.45	2.064	2:1:5	19.16	35.3	1.848	"
	36.5	23.8	1.989	"	10.34	35.7	1.672	"
	30.8	30.5	2.021	"	3.46	36.3	1.550	"
	28.9	34.1	2.078	" + 1:1:3	0.0	36.7	1.508	"
Cd·1 = CdCl ₂ ·H ₂ O				1:1:4 = CdCl ₂ ·BaCl ₂ ·4H ₂ O				
Cd2·5 = CdCl ₂ ·2.5H ₂ O				1:1:3 = CdCl ₂ ·BaCl ₂ ·3H ₂ O				
2:1:5 = 2CdCl ₂ ·BaCl ₂ ·5H ₂ O				Ba2 = BaCl ₂ ·2H ₂ O				

SOLUBILITY OF BARIUM - CADMIUM CHLORIDE DOUBLE SALTS IN WATER (Rimbach, 1897)

SOLUBILITY OF 2CdCl₂·BaCl₂·5H₂O IN WATER

t°	100 Gms. Solution contain Gms.			Gms. 2CdCl ₂ ·BaCl ₂ per 100 Gms.	
	Cd	Cl	Ba	Solution	Water
22.6	17.71	16.89	11.0	45.60	83.82
41.3	19.22	18.15	11.77	49.14	96.62
53.9	19.85	18.75	12.41	51.04	104.25
62.2	20.59	19.66	12.83	53.08	113.13
69.5	21.20	20.18	13.09	54.47	119.64
107.2	24.25	23.23	14.90	62.38	165.85

SOLUBILITY OF CdCl₂·BaCl₂·4H₂O IN WATER

t°	100 Gms. Solution contain Gms.			Gms. CdCl ₂ ·BaCl ₂ per 100 Gms.	
	Cd	Cl	Ba	Solution	Water
22.5	11.98	15.19	14.71	41.88	72.06
32.9	12.40	16.18	16.09	44.67	80.73
41.4	13.05	16.95	16.81	46.81	88.01
53.4	13.96	18.21	18.13	50.30	101.21
62.0	14.73	18.81	18.74	52.28	109.56
97.8	17.57	22.48	22.00	62.05	163.50
108.3	18.53	23.51	22.79	64.83	184.33
109.2	18.67	23.69	29.95	65.31	188.27

THE SYSTEM BARIUM CHLORIDE - COBALT CHLORIDE - WATER AT 20°
(Mazzetti, 1921)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoCl ₂	BaCl ₂		CoCl ₂	BaCl ₂	
6.34	16.50	BaCl ₂ ·2H ₂ O	29.57	0.88	BaCl ₂ ·2H ₂ O
13.14	10.03	"	33.80	0.38	"
19.52	5.48	"	34.15	0.37	"
24.92	2.01	"	34.43	0.45	" + CoCl ₂ ·6H ₂ O

C1

THE SYSTEM BARIUM CHLORIDE - CUPRIC CHLORIDE - WATER AT 30°
(Schreinemakers and deBaas, 1908-09)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
BaCl ₂	CuCl ₂		BaCl ₂	CuCl ₂	
0	43.95	CuCl ₂ ·2H ₂ O	5.49	30.75	BaCl ₂ ·2H ₂ O
1.25	42.45	"	10.13	21.76	"
3.08	42.07	" (unstable)	17.08	11.49	"
2.72	42.36	CuCl ₂ ·2H ₂ O + BaCl ₂ ·2H ₂ O	22.78	5.13	"
2.72	41.18	BaCl ₂ ·2H ₂ O	27.6	0	"
3.98	37.42	"			

Solubility data have been determined for the following systems:

BaCl₂·2H₂O + CuCl₂·2H₂O + NH₄Cl + H₂O at 30°. (Schreinemakers, 1909)
 " + " + KCl + H₂O at 40° and 60°. (" and deBatt, 1914)
 " + " + NaCl + H₂O at 30°. (" and deBatt, 1908-09)

Be BARIUM

THE SYSTEM BARIUM CHLORIDE - MERCURIC CHLORIDE - WATER

Gms. per 100
gma. sat. sol.

HgCl ₂	BaCl ₂	Solid Phase
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Results at 0°
(Schreinemakers, 1910)

0	23.70	BaCl ₂ ·2H ₂ O
14.25	24.00	"
36.20	24.89	"
46.08	24.05	BaCl ₂ ·3HgCl ₂ ·6H ₂ O + BaCl ₂ ·2H ₂ O
46.59	23.28	BaCl ₂ ·3HgCl ₂ ·6H ₂ O
47.78	21.05	"
48.46	20.67	" + HgCl ₂
44.33	18.50	HgCl ₂
29.00	11.59	"
16.36	6.11	"
3.95	0	"

Results at 10.4°
(Foote and Bristol, 1904)

50.54	23.58	BaCl ₂ ·2H ₂ O + HgCl ₂
50.74	23.44	BaCl ₂ ·3HgCl ₂ ·6H ₂ O
51.23	22.58	"
51.41	22.48	"
51.66	22.10	"
51.74	21.64	" + HgCl ₂

Results at 25°
(Bassett, Barton, Foster and Pateman, 1933)

0.0	27.08	BaCl ₂ ·2H ₂ O
8.10	26.54	"
14.98	26.73	"
32.45	26.07	"
43.51	25.22	"
51.34	23.82	"
53.69	23.23	"
53.83	23.11	"
54.84	22.85	" + HgCl ₂
54.43	21.96	HgCl ₂
44.58	16.23	"
35.36	11.19	"
15.07	3.28	"
6.90	0.0	"

(Cont.)

THE SYSTEM BARIUM CHLORIDE - MERCURIC CHLORIDE - WATER--Cont.

Gms. per 100 gms. sat. sol.		Solid Phase
HgCl ₂	BaCl ₂	
<u>Results at 30°</u> (Schreinemakers, 1910)		
0	27.77	BaCl ₂ ·2H ₂ O
2.90	27.56	"
12.98	26.99	"
34.57	26.69	"
46.50	25.22	"
55.22	23.17	" + HgCl ₂
48.97	17.87	HgCl ₂
41.30	14.26	"
27.62	8.41	"
14.19	2.65	"
7.67	0	"

Cl

THE SYSTEM BARIUM CHLORIDE - POTASSIUM CHLORIDE - WATER
(Foote, 1904)

100 gms. saturated solution contain 13.83 gms. BaCl₂ + 18.97 gms. KCl at 25°. (Foote, 1904)

A study of the freezing point depressions of various mixtures of BaCl₂ + KCl in water was made by Srivastava and Bose, 1954.

THE SYSTEM BARIUM CHLORIDE - LITHIUM CHLORIDE - WATER AT 25°
(Blidin, 1952, 1954)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
LiCl	BaCl ₂		LiCl	BaCl ₂	
45.95	0.0	LiCl·H ₂ O	10.15	14.32	BaCl ₂ ·2H ₂ O
34.12	1.52	BaCl ₂ ·2H ₂ O	5.16	20.13	"
28.91	3.02	"	1.52	24.56	"
23.34	5.54	"	0.0	26.75	"
17.48	8.28	"			

Ba BARIUM

THE SYSTEM BARIUM CHLORIDE - AMMONIUM CHLORIDE - WATER

At 30°. (Schreinemakers, 1908)				At Varying Temps. (Schreinemakers, 1910b)			
Gms. per 100 Gms. Sat. Sol.		Solid Phase	t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase	
BaCl ₂	NH ₄ Cl			BaCl ₂	NH ₄ Cl		
22.15	5.71	BaCl ₂ ·2H ₂ O	16.2	8.07	16.10	BaCl ₂ ·2H ₂ O + NH ₄ Cl	
18.36	10.06	"	0	8.22	19.26	"	+
15.42	13.84	"	30	8.19	24.89	"	+
10.89	20.01	"	40	8.40	26.39	"	+
8.33	24.69	"	50	8.55	29.53	"	+
7.97	25.92	BaCl ₂ ·2H ₂ O + NH ₄ Cl					
3.56	27.47	NH ₄ Cl					

Data for the quaternary system $\text{BaCl}_2 + 2\text{NH}_4\text{NO}_3 \rightleftharpoons \text{Ba}(\text{NO}_3)_2 + 2\text{NH}_4\text{Cl}$ in H_2O at 25° are given by Zdanovskii and Agranovskaya, 1941, and in diagram form by Zdanovskii, 1949.

THE SYSTEM BARIUM CHLORIDE - SODIUM CHLORIDE - WATER

Results at 20° (Findlay and Cruiokshank, 1926) The data of DiCapua and Bertoni, 1928 seem to be in error.			Results at 30° (Schreinemakers and deBaar, 1908-09)			Results at Varying Temps. (Precht and Wittgen, 1881; Rudorff, 1885)		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.	
NaCl	BaCl ₂		BaCl ₂	NaCl			BaCl ₂	NaCl
7.80	16.89	BaCl ₂ ·2H ₂ O	0	26.47	NaCl	20	2.9	25
9.54	14.99	"	2.28	25.28	"	40	4.5	23
14.50	10.04	"	3.80	23.77	" + BaCl ₂ ·2H ₂ O	60	6.8	23.4
18.52	6.51	"	5.76	20.25	BaCl ₂ ·2H ₂ O	80	9.4	22.8
21.23	4.17	"	8.19	17.89	"	100	11.8	22.2
24.59	3.07	" + NaCl	12.25	13.39	"			
25.28	1.65	NaCl	15.83	10.06	"			
			20.93	5.39	"			
			24.24	2.76	"			
			27.60	0	"			

INVARIANT SOLUTIONS IN THE SYSTEM $\text{BaCl}_2 - \text{KCl} - \text{NaCl} - \text{H}_2\text{O}$
(Yanatieva, 1947)

Temp.	Gms. per 100 gms. sat. sol.			Density	Solid Phases
	KCl	NaCl	BaCl_2		
0°	12.64	9.17	6.60	1.237	KCl + NaCl + $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
25°	15.94	8.77	7.14	1.262	"
50°	18.74	7.91	8.87	1.295	"

Results for the system $\text{BaCl}_2 \cdot 2\text{H}_2\text{O} + \text{HCl} + \text{NaCl} + \text{H}_2\text{O}$ at 30° are given by Schreinemakers 1909-10, 1910h.

Cl

THE SYSTEM BARIUM CHLORIDE - LEAD CHLORIDE - WATER AT 0° AND 25°
(Wolkow, 1927)

t°	Gms. per 100 gms. H_2O		Solid Phase	t°	Gms. per 100 gms. H_2O		Solid Phase
	PbCl_2	BaCl_2			PbCl_2	BaCl_2	
0	0.0	30.82	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	25	0.531	37.48	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
0	0.25	31.05	" + PbCl_2	25	0.745	37.55	"
0	0.0627	12.42	PbCl_2	25	0.87	37.55	" + PbCl_2
0	0.0635	5.16	"	25	0.659	33.88	PbCl_2
0	0.625	0.0	"	25	0.420	26.91	"
25	0.0	37.18	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	25	0.333	23.00	"
25	0.183	37.35	"	25	0.22	15.50	"
25	0.309	37.49	"	25	0.183	10.36	"
25	0.447	37.59	"	25	0.198	5.08	"
25	0.462	37.59	"	25	1.08	0.0	"

Results for the system $\text{BaCl}_2 + \text{PbCl}_2 + \text{HCl} + \text{H}_2\text{O}$ at 0° and at 25° are also given by Wolkow, 1927.

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS
OF URETHAN AND OF GLYCINE

of urethan at 25°
(Palitzsch, 1928, 1929)

Gm. Mols. per 1000 gms. H_2O		Solid Phase
$\text{NH}_4\text{COOC}_2\text{H}_5$	BaCl_2	
0.0	1.784	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
1.1067	1.789	"
7.435	1.397	" + $\text{NH}_2\text{COOC}_2\text{H}_5$

(Cont.)

Ba BARIUM

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS
OF URETHAN AND OF GLYCINE--Cont.of glycine at 20°
(Pfeiffer and Modelski, 1912)

Gms. per 100 cc. Sat. Sol.		Solid Phase
NH ₂ CH ₂ COOH	BaCl ₂	
5.5	37	BaCl ₂ ·2H ₂ O + BaCl ₂ ·2NH ₂ CH ₂ COOH·H ₂ O
26	16	NH ₄ CH ₂ COOH + BaCl ₂ ·2NH ₂ CH ₂ COOH·H ₂ O

Cl

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS

At 15°

(Schiff, 1861;
Rohland, 1897)

Wt. % C ₂ H ₅ OH	Gms. BaCl ₂ per 100 Gms. Solvent
10	31.1
20	21.9
30	14.7
40	10.2
60	3.5
80	0.5
97	0.014

At 20°

(Grinberg and Zemlyakova, 1948)

Solvent Wt. % C ₂ H ₅ OH	Solute	Gms. solute per 100-gms. sat. sol.
50	BaCl ₂	5.10
50	BaCl ₂ ·2H ₂ O	5.82

At 30°

(Schreinemakers and Messink, 1910)

Gms. per 100 Gms. Sat. Sol.		Solid Phase
C ₂ H ₅ OH	BaCl ₂	
0	27.95	BaCl ₂ ·2H ₂ O
32.67	10.63	"
50.16	5.68	"
60.72	2.23	"
92.53	0.05	"
94.73	0.06	" + BaCl ₂ ·H ₂ O
97.14	...	BaCl ₂ ·H ₂ O
98.17	0.08	" + BaCl ₂
99.41	...	BaCl ₂

At 60°

Gms. per 100 Gms. Sat. Sol.		Solid Phase
C ₂ H ₅ OH	BaCl ₂	
0	31.57	BaCl ₂ ·2H ₂ O
16.68	20.16	"
34.10	13.21	"
66.02	2.82	"
88.55	0.25	"
90.25	0.09	" + BaCl ₂ ·H ₂ O
93.95	...	BaCl ₂ ·H ₂ O

SOLUBILITY OF BARIUM CHLORIDE IN VARIOUS ORGANIC LIQUIDS

Methanol	6°	100 gms. methanol dissolve 7.3g BaCl ₂ ·2H ₂ O				(de Bruyn, 1892)
	15.5°	"	"	"	2.18g BaCl ₂	(")
Glycerol	15-16°	100 gms. glycerol dissolve 9.73g BaCl ₂				(Ossendowski, 1907)
Formic acid	19°	100 gms. 95% HCO ₂ H dissolve 7.3g BaCl ₂				(Aschan, 1913)
Nitrobenzene	20°	1 liter of sat. sol. contains 0.167g BaCl ₂				(Lloyd, 1918)
	50°	"	"	"	0.33g BaCl ₂	(")
	100°	"	"	"	0.40g BaCl ₂	(")
Acetic acid	25°	1 liter of sat. sol. contains 0.217g BaCl ₂				(Scholl, Hutchinson and Chandler, 1933)
	30°	A sat. sol. contains 0.0077 mole % BaCl ₂				(Davidson and Chapell, 1938)
	45°	"	"	"	0.0100 " " "	(")
		Gms. per liter sat. sol.		Gms. per liter sat. sol.		
		NaBr	BaCl ₂	NaBr	BaCl ₂	
Acetic Acid + NaBr	25°	0.00	0.217	0.051	0.252	(Scholl, Hutchinson and Chandler, 1933)
		0.010	0.227	0.077	0.255	
		0.026	0.235	0.124	0.287	
		0.036	0.246	0.165	0.308	
Ethylene glycol	25°	100 gms. ethylene glycol dissolve 36.8g BaCl ₂				(Isbin and Kobe, 1945)
Monoethanolamine	25°	" monoethanolamine " 45.2g BaCl ₂				(")
Ethylenediamine	25°	" ethylenediamine " 0.22g BaCl ₂				(")
		(SOLID PHASE = BaCl ₂ ·4C ₂ H ₄ (NH ₂) ₂)				
Tertiary Butyl Alcohol	25°	The composition of the homogeneous mixture (plait point) of the three components, as determined by the synthetic method, is 7.2 gms. BaCl ₂ , 34.1 gms. (CH ₃) ₃ COH and 58.7 gms. H ₂ O. Equations for the composition of the binodal curve are also given.				(Ginnings, Herring and Webb, 1933)
Triethylamine		Data for the system BaCl ₂ + Triethylamine + H ₂ O are given by Timmermans (1907).				

Ba BARIUM

SOLUBILITY OF BARIUM CHLORIDE IN VARIOUS ORGANIC LIQUIDS--Cont.

		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.				
		BaCl ₂	Dioxane	BaCl ₂	Dioxane			
c)	Dioxane - 25°	25.1	1.8	4.48	58.0	BaCl ₂ ·2H ₂ O		
	H ₂ O mixte.	25.0	4.0	1.96	68.7			
		22.9	9.6	1.21	72.4			
		20.2	15.8	0.64	76.1			
		17.0	22.6	0.01	89.9			
		11.2	37.2	0.00	93.73			
		9.51	41.2	0.00	98.20			
		8.15	45.6	0.00	99.05			
		5.45	54.4	0.00	99.58			" + BaCl ₂
	(Bogardus and Lynch, 1943)							
50% ethanol sat'd. w. benzene	20°	{ 100 gms. sat. sol. contain				(Grinberg and		
		{ 5.43 gms. BaCl ₂				Zemlyakova, 1948)		
		{ 100 gms. sat. sol. contain				(")		
		{ 5.82 gms. BaCl ₂ ·2H ₂ O						
50% ethanol sat'd. w. chloroform	20°	{ 100 gms. sat. sol. contain				(")		
		{ 6.02 gms. BaCl ₂						
		{ 100 gms. sat. sol. contain				(")		
		{ 6.82 gms. BaCl ₂ ·2H ₂ O						

SOLUBILITY OF BARIUM CHLORIDE IN SELENIUM OXYCHLORIDE (SeOCl₂)
(Wise, 1928)

	t°....	25°	40°	55°	70°
Gms. BaCl ₂ per 100 gms. sat. sol.....		3.95	2.35	1.23	0.71

INFLUENCE OF WATER UPON THE SOLUBILITY OF BARIUM CHLORIDE IN SELENIUM OXYCHLORIDE AT 25°

	0.0	0.0625	0.125	0.25	0.5	1.0
Moles H ₂ O per mol. SeOCl ₂						
Gms. BaCl ₂ per 100 gms. sat. sol.	3.95	3.86	3.37	2.32	1.40	0.45

SOLUBILITY IN HYDRAZINE AND LIQUID SULFUR DIOXIDE

100 cc. anhydrous hydrazine dissolve 31 gms. BaCl₂ at room temp.
(Welsh and Broderson, 1915)

100 gms. sat. sol. in liquid sulfur dioxide contain 0.03 gm. BaCl₂
at 25° (Watt, Jenkins and Robertson, 1950)

Melting point data have been determined for the following systems:

BaCl ₂ + BaCO ₃	(1)(27)	BaCl ₂ + KCl	(3)(11)(12)(23)
" + BaCrO ₄	(1)	" + " + MgCl ₂	(13)(14)
" + BaO	(1)(2)	" + " + NaCl	(15)(16)
" + BaSO ₄	(1)(3)	" + LiCl	(17)(18)
" + BaF ₂	(3)(4)(5)(26)	" + MgCl ₂	(10)(18)
" + BaI ₂	(3)	" + MnCl ₂	(3)(10)
" + BeCl ₂	(6)	" + Na ₂ CO ₃	(27)
" + CdCl ₂	(3)(7)(18)	" + Na ₂ SO ₄	(29)
" + CaCl ₂	(3)(7)(8)(18)(24)	" + NaCl	(1)(3)(12)(19)
" + " + SrCl ₂	(9)	" + RbCl	(20)(25)
" + " + NaCl	(28)(30)	" + SrCl ₂	(3)(7)(18)(12)(26)
" + " + KF + NaF	(31)	" + SrF ₂	(26)
" + KF	(32)	" + TlCl	(21)
" + CuCl	(18)	" + ZnCl ₂	(22)(18)

(1) Sackur, 1911-12; (2) Arndt, 1907; (3) Ruff and Plato, 1903; (4) Botta, 1911; (5) Plato, 1907; (6) Schmidt, 1926, 1929; (7) Sandonini, 1911; (8) Schaefer, 1914; (9) Schaefer, 1919; (10) Sandonini, 1912; (11) Sandonini, 1911; (12) Vortisch, 1914; (13) Valentin, 1922; (14) Matignon and Valentin, 1923; (15) Vortisch, 1914(a); (16) Gemskey, 1914; (17) Sandonini, 1913; (18) Sandonini, 1914; (19) LeChatelier, 1894; (20) Hofmann, 1927; (21) Korreng, 1914; (22) Sandonini, 1912(a); (23) Elchardus and Laffitte, 1932; (24) Gromakov and Gromakova, 1953; (25) Gromakov, 1950; (26) Bergman and Bukalova, 1949; (27) Belyaev and Sholokhov, 1953; (28) Alabyshev and Lantratov, 1946; (29) Speranskaya, 1940; (30) Bergman and Pavlenko, 1940; (31) Bukalova and Bergman, 1955 and (32) Banashek and Bergman, 1947.

BARIUM CHLORITE Ba(ClO₂)₂

C10

SOLUBILITY OF BARIUM CHLORIDE IN WATER (Levi, 1923)

t°	Gms. Ba(ClO ₂) ₂ per 100 gms. sat. sol.	t°	Gms. Ba(ClO ₂) ₂ per 100 gms. sat. sol.
0	30.5	50	33.4
15	31.0	75	38.6
35	31.6	100	44.7

Ba BARIUM

ClO BARIUM CHLORATE $\text{Ba}(\text{ClO}_3)_2$ SOLUBILITY IN WATER
(Trautz and Anschutz, 1906)

The data of DiCapua and Bertoni (1928), Ricci and Freedman (1952), Remy-Gennete and Durand (1955), and Foote and Hickey (1937) agree. The determinations made by Carlson, 1910 are 2-4% too high.

Solid Phase $\text{Ba}(\text{ClO}_3)_2 \cdot \text{H}_2\text{O}$

t°	Sp. Gr. of		Gms. $\text{Ba}(\text{ClO}_3)_2$ per		t°	Sp. Gr. of		Gms. $\text{Ba}(\text{ClO}_3)_2$	
	Sat.	Sol.	100 Gms.	Sat. Sol.		Sat.	Sol.	per 100 Gms.	Sat. Sol.
0	1.195		16.90		30	...		29.43	
10	1.198(R.&F.)		21.23(21.22 R.&F.)		40	1.355		33.16	
20	1.274		25.26(25.16 D.&B.)		60	1.433		40.05	
			(25.2 RG.&D.)		80	1.508		45.90	
25	1.263(R.&F.)		27.53(27.42 R.&F.)		100	1.580		51.2	
			(27.58 F.&H.)		105.6*	1.600		52.62	

*Boiling pt.

THE SYSTEM BARIUM CHLORATE - BARIUM HYDROXIDE - WATER AT 25*
(Foote and Hickey, 1937)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{ClO}_3)_2$		$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{ClO}_3)_2$	
0.0	27.58	$\text{Ba}(\text{ClO}_3)_2$	3.85	15.98	$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
1.87	26.17	"	4.02	8.79	"
3.71	26.58	" + $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$	4.489	0.0	"
3.77	21.85	$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$			

THE SYSTEM BARIUM CHLORATE - BARIUM NITRATE - WATER
(Ricci and Fraedman, 1952)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
Ba(ClO ₃) ₂	Ba(NO ₃) ₂	Density		Ba(ClO ₃) ₂	Ba(NO ₃) ₂	Density	
Results at 10°				Results at 25°			
21.22	0.00	1.198	A	27.42	0.00	1.263	A
21.38	4.52	1.249	A + E	26.82	7.94	1.362	A + C*
20.97	4.56	1.245	E	26.67	7.28	1.347	A + E
18.90	4.60	1.224	E	26.12	7.25	1.344	E
16.55	4.67	1.197	E	25.91	7.23	1.337	E
14.15	4.83	1.174	E	25.39	7.28	1.333	E
9.51	5.18	1.128	E	25.32	7.28	1.332	E
4.24	6.00	1.088	E	24.27	7.36	1.318	E
3.95	6.03	1.084	E	22.48	7.53	1.301	E
3.94	6.06	1.087	E	20.24	7.81	1.277	E
3.47	6.16	1.083	E + C	20.20	7.78	1.275	E
0.00	6.361	1.051	C	18.84	7.84	1.258	E
Results at 45°				18.29	7.96	1.254	E
34.90	0.00	1.347	A	17.32	8.09	1.243	E
32.48	10.16	1.465	A + C	15.08	8.39	1.222	E + C
0.00	13.60	1.110	C	0.00	9.246	1.079	C

A = Ba(ClO₃)₂·H₂O C = Ba(NO₃)₂ E = Ba(ClO₃)₂·6Ba(NO₃)₂·12H₂O

*metastable.

THE SYSTEM BARIUM CHLORATE - BARIUM CHLORIDE - WATER AT 25°
(Ricci and Freedman, 1951a)

Gms. per 100 gms. sat. sol.		Density	Solid Phase	Gms. per 100 gms. sat. sol.		Density	Solid Phase
Ba(ClO ₃) ₂	BaCl ₂			Ba(ClO ₃) ₂	BaCl ₂		
27.42	0.0	1.263	A	14.73	21.06	1.398	A + B
23.06	6.35	1.294	A	11.22	22.48	1.373	B
18.94	13.16	1.338	A	11.21	22.45	1.371	B
15.74	18.29	1.373	A	5.22	24.90	1.237	B

A = Ba(ClO₃)₂·H₂O B = BaCl₂·2H₂O

THE SYSTEM BARIUM CHLORATE - SODIUM CHLORATE - WATER AT 20°
(DiCapua and Bertoni, 1928)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NaClO ₃	Ba(ClO ₃) ₂		NaClO ₃	Ba(ClO ₃) ₂	
0.0	25.16	Ba(ClO ₃) ₂ ·H ₂ O	29.52	5.01	Ba(ClO ₃) ₂ ·H ₂ O
4.52	17.92	"	36.5	3.49	"
8.5	10.90	"	43.2	2.89	" + NaClO ₃
15.52	8.53	"	45.0	1.11	NaClO ₃
25.32	6.49	"	49.7	0.0	"

Ba BARIUM

SOLUBILITY OF BARIUM CHLORATE IN AQUEOUS ETHANOL SOLUTIONS AT 20° (Remy-Gennete and Durand, 1955)

Solvent				ml C ₂ H ₅ OH per 100 ml solvent	Gms. Ba(ClO ₄) ₂ ·H ₂ O per 100 gms. sat. sol.
ml alcohol + ml H ₂ O					
0	+	100	=	0	26.7
10	+	90	=	10.07	20.7
30	+	70	=	30.9	11.5
50	+	50	=	52.2	6.25
70	+	30	=	73	2.52
80	+	20	=	83	1.0
90	+	10	=	92.2	0.2
100	+	0	=	100	0.0

C10 BARIUM PERCHLORATE Ba(ClO₄)₂

SOLUBILITY IN WATER (Carlson, 1910)

The single determination by Willard and Smith, 1923 at 25° is in serious disagreement. It should be noted that Carlson's data on Ba(ClO₃)₂ (p. 354) were shown to be in error, and the data for Ba(ClO₄)₂ may also be unreliable.

Solid Phase Ba(ClO₄)₂·3H₂O

t°	Sp. Gr. Sat. Sol.	Gms. Ba(ClO ₄) ₂ per 100 Gms.		t°	Sp. Gr. Sat. Sol.	Gms. Ba(ClO ₄) ₂ per 100 Gms.	
		Sat.	Sol.			Sat.	Sol.
0	1.782	67.3		80	2.114	83.2	
20	1.912	74.3		100	2.155	84.9	
	(1.940)	(66.48)*		120	2.195	86.6	
40	2.009	78.2		140	2.230	88.3	
60	2.070	81					

*Willard and Smith, 1923

Freezing point depressions in 0.001-1.0 molal Ba(ClO₄)₂ solutions have been determined by Nicholson and Felsing, 1950.

SOLUBILITY OF BARIUM PERCHLORATE IN ORGANIC SOLVENTS AT 20°
(Willard and Smith, 1923)

Solvent	d_{4}^{25} of solvent	d_{4}^{25} of sat. sol.	Gms. Ba(ClO ₄) ₂ per 100 gms. sat. sol.
Water.....	...	1.9403	66.48
Methyl alcohol.....	0.78705	1.7507	68.46
Ethyl alcohol.....	0.78517	1.4157	55.48
n Propyl alcohol.....	0.7989	1.2145	43.07
n Butyl alcohol.....	0.8059	1.1342	36.78
iso Butyl alcohol.....	0.7852	1.4607	55.49
Acetone.....	0.7852	1.4607	55.49
Ethyl acetate.....	0.8923	1.5236	53.04

Furfurol....100 cc. dissolves about 50 gms. Ba(ClO₄)₂ } Chaney and Mann,
cellosolve..100 cc. dissolves about 100 gms. Ba(ClO₄)₂ } 1931

BARIUM Hexa Antipyrine PERCHLORATE Ba(COC₁₀H₁₂N₂)₆ (ClO₄)₂ ClO

100 cc. sat. solution of the salt in water contain 91.1 gm.
Ba(COC₁₀H₁₂N₂)₆ (ClO₄)₂ at 20°. (Wilke-Dörfurt and Schliephake, 1929).

BARIUM CHROMATE BaCrO₄ CrO

SOLUBILITY IN WATER
(Koklrausch, 1908; Beyer and Rieman, 1943; Mescherzski, 1882)

The results of Schweitzer, 1890 are 2-3 times as high as these.

t°	Gms. BaCrO ₄ per liter sat. sol.	t°	Gms. BaCrO ₄ per liter sat. sol.
0	0.002 (K.)	30	0.0046 (K.)
10	0.0028 (K.)	40	.00378 (B.&R.)
20	0.0037 (K.)	Boiling pt.	.043 (M.)
25	0.00291 (B.&R.)		

Ba BARIUM

SOLUBILITY OF BARIUM CHROMATE IN AQUEOUS SALT SOLUTIONS AT 25° (Beyer and Rieman, 1943)

The authors added 10 ml. of 0.01 N NH_3 , in order to prevent hydrolysis of the Barium Chromate, and diluted each solution to 1 liter.

Added Salt	Gms. per 1000 cc. sat. sol.		Added Salt	Gms. per 1000 cc. sat. sol.	
	Added salt	BaCrO_4		Added salt	BaCrO_4
None	0.0	0.00291	$\text{NaC}_2\text{H}_3\text{O}_2$	13.13	0.01019
$\text{NaC}_2\text{H}_3\text{O}_2$	0.21	.00355	"	16.61	.01077
CrO	0.82	.00459	"	20.51	.01201
"	1.84	.00537	NaCl	3.65	.00709
"	3.28	.00636	"	14.61	.01133
"	5.12	.00722	KCl	4.66	.00717
"	7.38	.00823	"	18.64	.01158
"	10.05	.00917	NH_4NO_3	(0.5%)	.022*
			$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	(1.5%)	.02*

*Results of Fresenius (1890) at room temperature.

APPROXIMATE SOLUBILITY OF BARIUM CHROMATE IN AQUEOUS SALT-SOLUTIONS (Waddell, 1918)

Freshly precipitated barium chromate was successively washed on a 11 cm. filter paper with 100 cc. portions of water and of various salt solutions. The dissolved chromate in the washings was determined by a new method of titration proposed by the author. The results do not show the maximum solubility but only the relative solubility under ordinary conditions of washing.

Solvent		Gms. BaCrO_4 per 1000 cc. wash solution	Solvent		Gms. BaCrO_4 per 1000 cc. wash solution
Water	.....	0.0078	10.0% NH_4NO_3	..	0.0489
1.0% $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	.....	.0280	10.0% KNO_3	....	.0178
10.0% "	.....	.0358	10.0% NaCl}	....	.0239
20.0% "	.....	.0507	1.0% $\text{HC}_2\text{H}_3\text{O}_2$	.	.1104
10.0% " + 10% $\text{HC}_2\text{H}_3\text{O}_2$	.....	.0877			

SOLUBILITY OF BaCrO_4 IN AQUEOUS ALCOHOL

One liter of 45% aq. ethyl alcohol solution dissolves 0.000022 gm. at room temp. (Guerini, 1912)

BARIUM FLUORIDE BaF_2

F

SOLUBILITY IN WATER

(Kohlrausch(1908); Talipov and Khadeev(1950); Booth and Bidwell (1950))

Gms. BaF_2 per t° liter sat. sol.			Gms. BaF_2 per t° 100 gms. H_2O		
10	1.586	(Kohlrausch)	200	0.0292	(Booth and Bidwell)
15	1.597	(")	214	.0258	(")
20	1.607	(")	242	.0220	(")
25	1.614	(")	258	.0139	(")
	1.620	(Talipov and	264	.0150	(")
		Khadeev)	280	.0102	(")
	(1.21)?	(Carter,	290	.0151	(")
		1928)*	311	.0085	(")
30	1.620	(Kohlrausch)	340	.0040	(")
			359	.0027	(")
*pH of sat. sol. = 4.4			370	.0021	(")
			395	.0018	(")

SOLUBILITY OF BARIUM FLUORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID
(Tanancoew and Tchrelachwill, 1936)

Paraffined vessels were used and the solutions were shaken 6 to 10 days. The normality of the HCl solutions used was 20.0l, 10.0 and 1.0. The barium was determined as sulfate, temp.?

Normality of HCl at beginning	Gm. Mols. BaF_2 dissolved per liter	pH of sat. sol.
0.01	0.0123	3.0
0.10	0.0414	1.6
1.0	0.1140	0.11

SOLUBILITY OF BARIUM FLUORIDE IN SOLUTIONS OF SODIUM AND
POTASSIUM FLUORIDES AT 25°
(Talipov and Khadeev, 1950)

moles per liter		Solid Phase BaF_2 Throughout moles per liter		moles per liter	
KF	BaF_2	KF	BaF_2	NaF	BaF_2
0.0	0.00923	0.3326	0.00030	0.03340	0.00236
0.0005002	.00910	.5020	.00022	.03902	.00208
.001233	.00871	In NaF solutions		.05020	.00164
.005028	.00775	NaF		.05281	.00142
.007031	.00713	KF		.1023	.00081
.01087	.00620			.1521	.00050
.02081	.00436	0.0	0.00923	.2563	.00039
.02480	.00343	.0001051	.00905	.3076	.00031
.05011	.00160	.0005112	.00889	.423	.00027
.07256	.00113	.001010	.00876	.603	.00016
.1001	.00075	.005601	.00713		
.1096	.00067	.01010	.00604		
.1507	.00054	.01941	.00400		
.2008	.00040	.02541	.00340		
.2571	.00030				

Ba BARIUM

SOLUBILITY OF BARIUM FLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE (Jache and Cady, 1952; Sheft, Hyman and Katz, 1953)

t°	Gms. BaF ₂ per 100 gms. HF		t°	Gms. BaF ₂ per 100 gms. HF	
-23.0	3.61	} J.&C.	25	4.72	} S.H.&K.
-3.3	4.74		70	7.06	
+12.2	5.6				

SOLUBILITY IN LIQUID SULFUR DIOXIDE AT 25° (Watt, Jenkins and Robertson, 1950)

100 gms. of saturated solution contain 0.02 gms. BaF₂.

Melting point data are given for the following.

BaF ₂ + BaI ₂ (1)	BaF ₂ + NaF (6)(10)
BaF ₂ + BaCl ₂ (1)(7)(8)(9)(10)(11)	BaF ₂ + SrF ₂ (12)
BaF ₂ + CaF ₂ (2)(8)	BaF ₂ + CaCl ₂ (Ternary system)(8)
BaF ₂ + KF (3)(9)	BaF ₂ + KCl (Ternary system)(9)
BaF ₂ + LiF (10)	BaF ₂ + LiCl (Ternary system)(7)
BaF ₂ + MgF ₂ (4)(5)	BaF ₂ + NaCl (") (10)
	BaF ₂ + RbCl (") (11)

(1) (Ruff and Plato, 1903); (2) (Fuseya-Mori-Imamura, 1933);
 (3) (Puschin and Baskov, 1913); (4) (Grube, 1927, Jaisle, 1926);
 (5) (Fuseya-Mori-Imamura, 1933); (6) (Grube, 1927, Jaisle, 1926);
 (7) (Bergman and Banashek, 1953); (8) (Bukhalova and Bergman, 1951);
 (9) (Banashek and Bergman, 1950); (10) Banashek and Bergman, 1947);
 (11) (Banashek, 1950); (12) (Bergman and Bukalova, 1949).

POF BARIUM FLUOPHOSPHATE (Phospho FLUORIDE) BaPO₃F

One liter sat. solution in water contains 6.1×10^{-4} gm. mol.
 (= 0.0141 gm.) BaPO₃F at 20°. (Lange, 1929).

SIF BARIUM FLUOSILICATE (Silico FLUORIDE) BaSiF₆

SOLUBILITY OF BARIUM FLUOSILICATE IN WATER (Carter, 1930)

The purity of the sample was at least 98 percent, with only small amounts of silica or fluorides as impurities. The solutions were agitated for one hour and allowed to stand 24 hours.

t°	Gms. BaSiF ₆ per 100 cc. sat. sol.	t°	Gms. BaSiF ₆ per 100 gms. sat. sol.
0	0.015	45	0.031
16	0.019	55	0.035
25	0.025	78	0.044
35	0.028		

SOLUBILITY OF BaSiF_6 IN OTHER SOLUTIONS
(Leo, 1923)

100 gms. of a saturated solution in a solvent composed of 500 cc. H_2O + 30 cc. 1.0 N HCl + 5 gms. $(\text{NH}_4)_2\text{SiF}_6$ contain 0.013 gm. BaSiF_6 at 18.5° .

100 gms. of a sat. solution in a solvent composed of 270 cc. H_2O + 15 cc. 1.0 N HCl + 2.5 gm. $(\text{NH}_4)_2\text{SiF}_6$ + 95 cc. $\text{C}_2\text{H}_5\text{OH}$ contain 0.0082 gm. BaSiF_6 at 18.5° .

BARIUM Meta GERMANATE BaGeO_3

GeO

100 gms. sat. solution in water contain 0.07536 gm. BaGeO_3 at 25° . (Müller and Gulezian, 1929).

BARIUM IODIDE BaI_2

SOLUBILITY OF BARIUM IODIDE IN WATER
(Packer and Rivett, 1926)

t°	$d_4^{t^\circ}$ of sat. sol.	Gms. BaI_2 per 100 gms. sat. sol.	Solid Phase	t°	$d_4^{t^\circ}$ of sat. sol.	Gms. BaI_2 per 100 gms. sat. sol.	Solid Phase
-1.0	1.060	7.00	Ice	-5.8	2.036	61.45	$2\text{BaI}_2 \cdot 15\text{H}_2\text{O}$
-1.7	1.117	12.4	"	0.0	2.051	62.5	"
-3.7	1.221	21.35	"	+ 5.0	2.105	63.6	"
-5.35	1.281	26.05	"	10.0	2.144	64.8	"
-7.75	1.371	32.05	"	15.0	2.176	65.75	"
-9.35	1.423	35.15	"	19.9	2.222	67.15	"
-12.35	1.507	39.90	"	25.0	2.277	68.8*	"
-14.95	1.568	42.95	"	25.7	...	68.9	" + $\text{BaI}_2 \cdot 2\text{H}_2\text{O}$
-18.15	1.634	46.1	"	26.0	2.282	68.9	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$
-22.9	1.731	50.4	"	30.0	2.287	64.1	"
-24.6	1.764	51.5	"	40.0	2.304	69.6	"
-30.2	1.842	54.6	"	50.0	2.32	70.1	"
-33.5	...	56.0	" + $2\text{BaI}_2 \cdot 15\text{H}_2\text{O}$	60.0	2.331	70.7	"
-29.75	1.905	56.8	$2\text{BaI}_2 \cdot 15\text{H}_2\text{O}$	69.5	2.35	71.15	"
-25.4	1.927	57.5	"	87.7	...	72.55	"
-20.0	1.952	58.6	"	98.9	...	73.35	" + $\text{BaI}_2 \cdot \text{H}_2\text{O}$
-15.4	1.983	59.65	"	110.0	...	74.0	$\text{BaI}_2 \cdot \text{H}_2\text{O}$
- 9.7	2.012	60.65	"	120.0	...	74.3	"

*Rivett and Packer, 1927 report 68.8% as the metastable solubility of $\text{BaI}_2 \cdot 2\text{H}_2\text{O}$ at 25° . Millikan, 1917 gives 68.59%.

8a BARIUM

EQUILIBRIUM IN THE SYSTEM $\text{BaI}_2 + \text{BaO} + \text{H}_2\text{O}$ at 25° (Millikan, 1917)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
BaO	BaI ₂	Solid Phase	BaO	BaI ₂	Solid Phase
0.0	68.59	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$	1.67	49.85	$\text{BaI}_2 \cdot \text{BaO} \cdot 9\text{H}_2\text{O}$
0.24	68.52	" + $\text{BaI}_2 \cdot \text{BaO} \cdot 9\text{H}_2\text{O}$	3.14	44.99	" + $\text{BaO} \cdot 9\text{H}_2\text{O}$
0.36	62.76	$\text{BaI}_2 \cdot \text{BaO} \cdot 9\text{H}_2\text{O}$	3.08	42.28	$\text{BaO} \cdot 9\text{H}_2\text{O}$
0.40	60.33	"	3.00	32.92	"
0.64	56.77	"	3.01	28.43	"
1.04	53.68	"	3.25	18.38	"
1.25	52.39	"	4.05	0.0	"

EQUILIBRIUM IN THE SYSTEM BARIUM IODIDE, IODINE AND WATER (Rivett and Packer, 1927)

No evidence of a periodide was found, as reported by Herz and Bulla, 1911.

t°	d _t of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	t°	d _t of eat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		I ₂	BaI ₂				I ₂	BaI ₂	
-15.8	...	15.9	50.4	$2\text{BaI}_2 \cdot 15\text{H}_2\text{O}$	25	...	33.8	44.8	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$
"	...	37.6	38.7	"	"	...	46.8	36.4	"
"	...	51.4	32.2	" + I ₂	"	...	58.6	28.8	"
"	...	50.8	31.2	I ₂	"	...	61.0	27.4	" + I ₂
"	...	47.5	30.8	"	"	...	50.0	26.6	I ₂
"	...	37.6	28.6	" + Ice	"	1.827	33.2	24.8	"
"	...	31.3	31.4	Ice	"	1.438	19.5	19.3	"
"	...	12.7	38.7	"	"	1.214	10.0	12.4	"
"	...	0.0	43.5	"	"	1.081	3.7	5.8	"
0	2.071	0.0	62.5	$2\text{BaI}_2 \cdot 15\text{H}_2\text{O}$	50	...	68.3	22.1	"
"	2.108	3.0	60.7	"	"	...	47.2	24.5	"
"	2.167	8.2	57.7	"	"	...	24.9	19.9	"
"	2.322	20.3	50.4	"	"	...	10.1	11.0	"
"	2.561	35.1	41.7	"	75.2	...	21.0	56.6	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$
"	...	47.7	35.1	"	"	...	41.6	41.8	"
"	...	49.4	34.6	" + $\text{BaI}_2 \cdot 2\text{H}_2\text{O}$	"	...	60.7	28.6	"
"	...	51.8	32.7	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$	"	...	67.2	24.2	" + $\text{BaI}_2 \cdot \text{H}_2\text{O}$
"	...	54.0	31.4	" + I ₂	"	...	74.9	18.9	$\text{BaI}_2 \cdot \text{H}_2\text{O}$
"	2.415	45.4	29.0	I ₂	"	...	78.3	16.8	"
"	1.780	29.5	25.5	"	"	...	82.0	14.3	" + I ₂
"	1.365	15.2	17.9	"	"	...	77.6	15.7	I ₂
"	1.169	7.4	10.5	"	"	...	70.0	18.0	"
25	2.277	0.0	68.8	$\text{BaI}_2 \cdot 2\text{H}_2\text{O}$	"	...	42.5	21.4	"
"	2.31	2.7	66.7	"	"	...	23.0	17.0	"
"	2.339	6.5	64.3	"	"	...	9.8	9.4	"
"	...	11.7	60.6	"	89.9	...	75.3	14.7	"
"	2.405	13.3	59.7	"	"	...	83.4	12.8	"
"	...	24.0	52.0	"					

THE SYSTEM BARIUM IODIDE - MERCURIC IODIDE - WATER

A saturated solution of BaI_2 and HgI_2 in water at 23.5° was found by Duboin (1906) to have the composition $BaI_2 \cdot 1.33HgI_2 \cdot 7.76H_2O$, $d = 2.76$.

Freezing points in the system BaI_2 -Urea- H_2O were determined by Pande and Bhatnager, 1955. The results are given in terms of ml 1.0M urea solution added to 10 ml of 0.5M BaI_2 solution. Freezing points between 0 and -2° are given, and the results interpreted as the formation of several complexes.

SOLUBILITY OF BARIUM IODIDE IN VARIOUS SOLVENTS

Solvent	t°	Gms. BaI_2 per 100 gms. sat. sol.	Ref.	Solvent	t°	Gms. BaI_2 per 100 gms. sat. sol.	Ref.
Abs. C_2H_5OH	0	77.75	(1)	97% C_2H_5OH	15	1.07	(2)
	10	77.35		95% $HCOOH$	20.2	75.	(3)
	20	77.00		Pyridine	25	8.22	(4)
	30	76.60		Liq. NH_3	0	0.232	(5)
	40	76.20		Liq. SO_2	0	0.71	(6)
	50	75.85			25	0.10	(7)
	60	75.50					
	70	75.10					

(1) Bonnell and Jones, 1926; (2) Rohland, 1897; (3) Aschan, 1913; (4) Miller, 1924; (5) Linhard and Stephen, 1933, 1934; (6) Jander and Ruppolt, 1937. (In a preceding paper by Jander and Wickert, 1936, the figure 1.71 instead of 0.71 gm. BaI_2 is given.) (7) Watt, Jenkins and Robertson, 1950.

Melting point data are given for

$BaI_2 - SrI_2$ } Eastman, Melchoir and Stickland, 1950.
 $BaI_2 - SrBr_2$ }

BARIUM IODATE $Ba(IO_3)_2$

10

SOLUBILITY IN WATER

The determinations of Trautz and Anschütz, 1906 (from $0-100^\circ$) are inexplicably too low. The values of Harkins and Winnighoff, 1911 and Ricci and Freedman, 1952a at 25° differ slightly from those listed below. That of Hill and Zink, 1909 is very low.

t°	Gms. $Ba(IO_3)_2$ per liter sat. sol.	Author
18	0.327	Pederson, 1941
25	.395	MacDougall and Davies, 1935
	.396	Davies and Wyatt, 1949
	.3951	Keefer, Rieber and Bisson, 1940
	.3968	Davis, Ricci and Sauter, 1939
	.396	Monk, 1951
	.394	Derr and Vosburgh, 1943
35	.511	Davies and Wyatt, 1949

For comparison, Trautz and Anschütz found: 10° , 0.14; 25° , 0.28; 40° , 0.41; 60° , 0.74; 80° , 1.15; 100° , 1.97.

Ba BARIUM

THE SYSTEM BARIUM IODATE - IODIC ACID - WATER AT 25° (Ricci and Freedman, 1952)

Gms. per 100 gms. sat. sol.		Den- sity	Solid Phase	Gms. per 100 gms. sat. sol.		Den- sity	Solid Phase
I ₂ O ₅	Ba(IO ₃) ₂			I ₂ O ₅	Ba(IO ₃) ₂		
0.0	0.042	...	Ba(IO ₃) ₂ ·H ₂ O	66.76	nil	2.27	1:1
53.09	nil	1.805	"	67.70	nil	2.31	1:1
53.29	nil	1.804	" + 1:1	68.56	nil	2.35	1:1
58.92	nil	1.970	1:1	71.00	nil	2.47	1:1
60.73	nil	2.019	1:1	71.47	nil	2.49	1:1 + HIO ₃
1:1 = Ba(IO ₃) ₂ ·I ₂ O ₅				71.47	0.0	2.49	HIO ₃

SOLUBILITY OF BARIUM IODATE IN HCl AND HNO₃ SOLUTIONS AT 25° (Naidich and Ricci, 1939)

Gms. per liter		Gms. per liter	
HCl	Ba(IO ₃) ₂	HNO ₃	Ba(IO ₃) ₂
0.004	0.4019	0.0694	0.4119
0.018	.4057	0.3469	.4472
0.036	.4092	0.6939	.4777
0.091	.4214	3.469	.6699
0.182	.4378	6.939	.8541
0.365	.4655	15.59	1.258
1.828	.6207	31.18	1.919
3.654	.7586	62.36	3.351
8.950	1.088		
17.899	1.578		
35.803	2.554		

The solubility of Ba(IO₃)₂ in aq. HNO₃ at the boiling point was studied by Komar, 1941.

SOLUBILITY OF BARIUM IODATE IN AQUEOUS AMMONIA SOLUTIONS AT 25° (Derr and Vosburgh, 1943)

- gms. per 1000 gms. H ₂ O -							
NH ₃ :	0.0	2.864	6.662	15.22	17.30	"Conc"	
Ba(IO ₃) ₂ :	0.394	0.401	0.404	0.375	0.373	See below*	

*100 cc. conc. ammonia (Sp. Gr. 0.90) dissolve 0.0199 gm. Ba(IO₃)₂ at room temp. (Hill and Zink, 1909).

THE SYSTEM BARIUM IODATE - BARIUM BROMIDE - WATER AT 25°
(Ricci and Freedman, 1952a)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Ba(IO ₃) ₂	BaBr ₂	Solid Phase	Ba(IO ₃) ₂	BaBr ₂	Solid Phase
0.042	0.0	Ba(IO ₃) ₂ ·H ₂ O	0.045	44.61	Ba(IO ₃) ₂ ·H ₂ O
0.013	11.19	"	0.068	49.02	"
0.017	22.34	"	0.075	50.07	" + BaBr ₂
0.026	33.46	"			

THE SYSTEM BARIUM IODATE - BARIUM NITRATE - WATER AT 25°

(Ricci and Freedman, 1952a)			(Harkins and Winninghoff, 1911)	
Gms. per 100 gms. sat. sol.			Gms. per 100 cc. sat. sol.	
Ba(NO ₃) ₂	Ba(IO ₃) ₂	Solid Phase	Ba(NO ₃) ₂	Ba(IO ₃) ₂
0.0	0.042	Ba(IO ₃) ₂ ·H ₂ O	0.0261	0.0331
2.50	.019	"	0.0523	.0294
4.75	.023	"	0.1307	.0237
7.14	.027	"	0.523	.0164
8.69	.031	"	1.307	.0149
9.22	.033	" + Ba(NO ₃) ₂	2.614	.0148
			5.228	.0136

SOLUBILITY OF BARIUM IODATE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS

In KCl solutions at 25°

(MacDougall and Davies, 1935; Keefer, Rieber and Bisson, 1949; Naidich and Ricci, 1939)

The data of K.R. and B. are practically identical with those of M. and D. (listed below). Those of N. and R. are 0.5 - 1% higher, becoming more in agreement at higher concentrations.

Gm. Mols. per liter		Gm. mols. per liter	
KCl	Ba(IO ₃) ₂	KCl	Ba(IO ₃) ₂
0.0	0.000810	0.02	0.000985
0.001	0.000827	0.05	0.001117
0.002	0.000840	0.10	0.001269
0.0035	0.000859	0.246	0.001567 (N. and R.)
0.005	0.000874	0.491	0.001892 (")
0.0075	0.000899	0.981	0.00238 (")
0.01	0.000918		

Ba BARIUM

SOLUBILITY OF BARIUM IODATE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS--Cont.

In KNO_3 solutions at 25°

The data are not in good agreement.

	(MacDougall and Davies, 1935) moles per liter		(Naidich and Ricci, 1939) moles per liter		(Harkins and Winninghoff, 1911) moles per liter	
	KNO_3	$\text{Ba}(\text{IO}_3)_2$	KNO_3	$\text{Ba}(\text{IO}_3)_2$	KNO_3	$\text{Ba}(\text{IO}_3)_2$
10	0.001	0.000826	0.00050	0.000839	0.002	0.000813
	0.002	0.000841	.00100	0.000893	0.010	0.000913
	0.0035	0.000863	.00250	0.001177	0.050	0.001320
	0.005	0.000880	.00505	0.001366	0.200	0.001594
	0.0075	0.000906	.0100	0.00176		
	0.01	0.000932	.0491	0.00229		
	0.02	0.001006	.0981	0.00323		
	0.05	0.001156				
	0.10	0.001361				

In KClO_3 , KClO_4 , CaCl_2 solutions at 25°

(MacDougall and Davies, 1935)

In aq. KClO_3 Gm. Mols. per liter		In aq. KClO_4 Gm. Mols. per liter		In aq. CaCl_2 Gm. Mols. per liter	
KClO_3	$\text{Ba}(\text{IO}_3)_2$	KClO_4	$\text{Ba}(\text{IO}_3)_2$	CaCl_2	$\text{Ba}(\text{IO}_3)_2$
0.005	0.000880	0.004	0.000866	0.002061	0.000884
0.01	0.000924	0.008845	0.000905	0.004961	0.000955
0.02854	0.001031	0.035	0.001045	0.009928	0.001046
0.075	0.001184	0.075	0.001164		

In $\text{Na}_2\text{S}_2\text{O}_3$, $\text{BrCH}_2\text{COONa}$ Solutions

(Davies and Wyatt, 1949)

moles per liter		moles per liter		moles per liter	
$\text{Na}_2\text{S}_2\text{O}_3$ at 25°	$\text{Ba}(\text{IO}_3)_2$	$\text{Na}_2\text{S}_2\text{O}_3$ at 35°	$\text{Ba}(\text{IO}_3)_2$	$\text{BrCH}_2\text{COONa}$ at 25°	$\text{Ba}(\text{IO}_3)_2$
0.0	0.000812	0.0	0.001049	0.0	0.000812
0.005025	0.001022	0.005010	0.001322	0.010	0.000920
0.008030	0.001097	0.008016	0.001415	0.015	0.000954
0.01005	0.001137	0.01002	0.001467	0.020	0.000986
0.01508	0.001223	0.01503	0.001579	0.025	0.001012
0.02009	0.001295	0.02006	0.001680		

In KIO_3 solutions at 25°

(Harkins and Winninghoff, 1911)

	moles per liter	
KIO_3 :	0.000106	0.001061
$\text{Ba}(\text{IO}_3)_2$:	0.000755	0.000470

In NH_4Cl solution at 25°

(Derr and Vosburgh, 1943)

Gms. per 1000 gms. H_2O	
NH_4Cl	$\text{Ba}(\text{IO}_3)_2$
1.83	0.413

SOLUBILITY OF BARIUM IODATE IN SOLUTIONS CONTAINING BOTH
GLYCINE AND POTASSIUM CHLORIDE AT 25°
(Keefer, Rieber, and Blason, 1940)

Gms. per 1000 gms. H ₂ O			Gms. per 1000 gms. H ₂ O		
KCl	Glycine	Ba(IO ₃) ₂	KCl	Glycine	Ba(IO ₃) ₂
0.1876	1.885	0.5043	.3763	56.74	.5798
.1878	3.776	.5145	.3767	75.75	.5910
.1880	5.669	.5252	.7522	18.90	.6319
.1882	7.567	.5359	.7530	37.84	.6436
.3754	18.87	.5564	.7537	56.83	.6558
.3758	37.78	.5681	.7544	75.82	.6680

10

SOLUBILITY OF BARIUM IODATE IN GLYCINE AND ALANINE SOLUTIONS AT 25°
(Keefer, Rieber, and Blason, 1940; Monk, 1951)

Glycine				Alanine			
K.R. and B. Moles per 1000 gm. H ₂ O		Monk moles per liter		K.R. and B. Moles per 1000 gms. H ₂ O		Monk moles per liter	
Glycine	Ba(IO ₃) ₂	Glycine	Ba(IO ₃) ₂	Alanine	Ba(IO ₃) ₂	Alanine	Ba(IO ₃) ₂
0.0251	0.000831	0.1537	0.000931	0.0251	0.000829	0.1500	0.000913
.0503	.000851	.3572	.001118	.0503	.000843		
.0755	.000871			.0755	.000858		
.1008	.000895			.1008	.000876		
.1990	.000977						
.8175	.001552						

Monk also gives data for the solubilities with KCl and KIO₃ added to the above solutions.

SOLUBILITY OF Ba(IO₃)₂ IN GLYCYL-GLYCINE SOLUTIONS AT 25°
(Monk, 1951)

		moles per liter	
Glycyl-glycine:	0.0344	0.0578	0.0632
Ba(IO ₃) ₂ :	0.000853	0.000895	0.000912

SOLUBILITY OF BARIUM IODATE IN UREA SOLUTIONS AT 17.9°
(Pederson, 1941)

Moles Urea per liter of solvent	Moles Ba(IO ₃) ₂ per liter of sat. sol.	Moles Urea per liter of solvent	Moles Ba(IO ₃) ₂ per liter of sat. sol.
0.0	0.0006706*	0.600	0.0007510
0.0	0.0006694	0.800	0.0007787
0.200	0.0006965	1.000	0.0008059
0.400	0.0007240		

*at 18.0°.

Ba BARIUM

SOLUBILITY OF BARIUM IODATE IN VARIOUS AQUEOUS ORGANIC SOLVENTS AT 25°
(Monk, 1951b; Davis, Ricci and Sauter, 1939; Hill and Zink, 1909)

Solvent	Wt. %	Gms. Ba(IO ₃) ₂ per liter sat. sol.	Solvent	Wt. %	Gms. Ba(IO ₃) ₂ per liter sat. sol.
Methanol	4.72	0.278	Dioxane	2.2	0.349
	9.53	.197		4.7	.294
	14.43	.138		9.4	.230
Ethanol	3.82	.283		10	.2310
	7.67	.204		20	.1231
	11.59	.147		30	.0593
	95.	.011(H. and Z.)		40	.0269
Acetone	4.09	.292		50	.0135
	8.25	.217		60	.0068
	12.46	.159		70	.0054
n-	4.16	.282		80	.0036
propanol	8.40	.201		90	.00024
	12.71	.143		100	.00000
Ethyl	3.8	.313	Glycerol	6.31	.381
acetate	6.1	.273		12.44	.367
Glycol	5.62	.350		18.43	.355
	11.24	.312			
	16.85	.279			

D. R.
and S.

MnO BARIUM PERMANGANATE Ba(MnO₄)₂

Results for the system Ba(MnO₄)₂ + KMnO₄ + H₂O at 25° are given by
Benrath and Schaackman, 1934.

MoO BARIUM MOLYBDATE BaMoO₄

100 parts water dissolve 0.0058 part BaMoO₄ at 23°. (Smith and
Bradbury, 1891).

The solubility product constant $K_{sp} = 3.41 \times 10^{-8}$ at room
temperature. (Rao, 1953, 1954).

N BARIUM AZIDE Ba(N₃)₂

SOLUBILITY OF BARIUM AZIDE IN WATER
(Curtius and Rissom, 1898)

t°	0	10.5	15	17
Gms. Ba(N ₃) ₂ per 100 gms. sat. sol.	11.1	13.9	14.3	14.8

BARIUM NITRITE $\text{Ba}(\text{NO}_2)_2$

NO

SOLUBILITY IN WATER

The results of Bureau, 1937 do not agree with those of Oswald, 1914 (see also Vogel, 1903). The authors' curves intersect at 15° and at 98°, but at other temperatures differ by as much as 2%. The determinations along the ice curve are in excellent agreement. Bureau thinks there are two varieties of $\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ with a transition point at 40°, but due to viscosity and tendency for supersaturation he could not isolate the two forms. It may be of interest to note that the combination of B.'s data below 19° and above 98°, with O.'s between these temperatures lies on a straight line.

Data of Oswald, 1914

t°	Gms. $\text{Ba}(\text{NO}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase
-1.7	9.2	I
-3.2	19.5	I
-5.8	33.1	I
-6.5	34.5	I + B
-4.3	34.9	B
+17	40.0 ^a	B
20	40.3	B
43	50.3	B
61	58.6	B
80	67.3	B
92	71.7	B
110	82.0	B

Data of Bureau, 1937

t°	Gms. $\text{Ba}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $\text{Ba}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase
-1.4	7.7	I	35.2	49.9	Ba
-3.05	17.05	I	37.0	50.3 ^e	Ba
-5.25	26.8	I	40.4	51.6 ^f	Ba
-5.85	29.35	I + Ba	40.0	52.0	Ba + Bβ
+1.0	31.8 ^b	Ba	56.0	58.12 ^g	Bβ
6.65	34.3	Ba	58.5	60.8	Bβ
16.0	39.8	Ba	79.5	67.9 ^h	Bβ
21.0	41.7 ^c	Ba	98.2	75.1 ⁱ	Bβ
32.1	47.9 ^d	Ba	114.5*	81.25	Bβ

I = Ice B = $\text{Ba}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ * - Boiling point

densities: a = 1.4897, b = 1.359, c = 1.492, d = 1.584, e = 1.612,
f = 1.616, g = 1.814, h = 2.105, i = 2.308.

Ba BARIUM

THE SYSTEM BARIUM NITRITE - THALLOUS NITRITE - WATER AT 25°
(Cavalca, Nardelli and Braibanti, 1955)

Gms. per 100 gms. sat.sol.		Solid Phase
TlNO ₂	Ba(NO ₂) ₂	
28.95	16.18	TlNO ₂
31.82	26.74	TlNO ₂ + TlNO ₂ ·2Ba(NO ₂) ₂
29.62	27.36	TlNO ₂ ·2Ba(NO ₂) ₂
23.49	28.97	"
11.85	38.05	"
5.35	43.84	" + Ba(NO ₂) ₂ ·H ₂ O
3.09	43.91	Ba(NO ₂) ₂ ·H ₂ O

SOLUBILITY OF BARIUM NITRITE IN AQUEOUS ALCOHOL SOLUTIONS AT 19.5°-20.5°
(Vogel, 1903)

% alcohol in solvent:	10	20	30	40	50	60	70	80	90
Gms. Ba(NO ₂) ₂ ·H ₂ O	49.3	29.3	18.4	13.3	9.1	4.8	2.7	0.98	0
per 100 cc. sat. sol.									

NO BARIUM NITRATE Ba(NO₃)₂

SOLUBILITY OF BARIUM NITRATE IN WATER

The closely agreeing determinations of Flottmann, 1928; Chlopin, Polessitzki and Tolmotschew, 1929; Friend and Wheat, 1933; and Sieverts and Petzold, 1933; were plotted on cross section paper and the following figures read from the curve. According to Friend and Wheat the grams of Ba(NO₃)₂ dissolved per 100 gms. of saturated solution in water is expressed by the equation $S = 4.70 + 0.173t + 0.00045t^2$. The results above 100° are by Benrath, Gjedebø, Schiffers and Wunderlich, 1937.

[Solid phase Ba(NO₃)₂ throughout]

t°	Gms. Ba(NO ₃) ₂ per 100 gms. sat. sol.	t°	Gms. Ba(NO ₃) ₂ per 100 gms. sat. sol.	t°	Gms. Ba(NO ₃) ₂ per 100 gms. sat. sol.
-0.55(Eutee.)	4.56	60	16.9	210	45.6
0	4.72	70	19.1	226	48.6
5	5.4	80	21.4	239	50.6
10	6.25	90	23.6	256	53.0
15(d=1.0616)	7.27	100	25.6	276	56.6
20(d=1.0691)	8.27	112	28.4	297	61.0
25(d=1.0768)	9.27	135	32.0	320	64.8
30	10.30	158	36.4	348	70.0
40	12.35	171	38.6	380	76.1
50	14.6	191	42.1	417	82.3

SOLUBILITY OF BARIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID

Due to the possibility of error resulting from the action of light on concentrated nitric acid, the acid used by Greene, 1937 was distilled in a dark room exposed only to red light, and the solubility flasks were protected from white light at all times. Nitrous acid was determined in all solutions containing more than 50% HNO_3 . The largest amount found in any sample was 0.003% while most of the samples contained less than 0.001%.

Results at 0° (Greene, 1937)			Results at 24.88° (Greene, 1937)			NO
(See also Tolmatschew, 1930)			(See also Tolmatschew, 1930)			
d_{25}° of sat. sol.	Gms. per 100 gms. sat. sol.		d_{25}° of sat. sol.	Gms. per 100 gms. sat. sol.		
	HNO ₃	Ba(NO ₃) ₂		HNO ₃	Ba(NO ₃) ₂	
1.3416	56.42	0.00982	1.0769	0.0	9.23	
1.3558	59.00	0.00635	1.1221	20.65	0.495	
1.3763	63.21	0.00224	1.1966	32.71	0.199	
1.3975	67.88	0.00118	1.2907	47.60	0.0484	
1.4143	71.93	0.000506	1.343	56.60	0.0147	
1.4177	72.82	0.000406	1.355	59.06	0.0100	
			1.373	62.77	0.00532	
			1.395	67.30	0.00223	
			1.415	71.45	0.000865	
			1.430	75.14	0.000404	
			1.442	78.51	0.000197	
			1.463 *	85.37	0.0000257	
			1.480	92.10	0.0000191	
Results at 15° (Chlopin, 1925)			Results at 30° (Masson, 1911)			
	Gms. per 100 cc. sat. sol.			Gms. per 100 cc. sat. sol.		
	HNO ₃	Ba(NO ₃) ₂	d_{30}° of sat. sol.	HNO ₃	Ba(NO ₃) ₂	
	0.0	8.03				
	1.16	6.25				
	2.23	5.63				
	4.30	4.23				
	10.07	2.07				
	18.39	1.15				
Results at 18° (Fricke and Brummer, 1933)						
d_{18}° of sat. sol.	Gm. Equiv. per 1000 gms. sat. sol.					
	HNO ₃	Ba(NO ₃) ₂				
1.0643	0.0	0.6018	1.0891	0.0	11.16	
1.0617	0.0487	0.5612	1.0811	0.8303	9.624	
1.0602	0.0774	0.5383	...	1.572	8.542	
1.0563	0.1569	0.4817	1.0663	3.149	6.300	
1.0503	0.3212	0.3747	1.0619	4.718	4.665	
1.0450	0.7350	0.2419	1.0609	6.3	3.536	
1.0487	0.8572	0.1845	1.0633	7.854	2.76	
1.0565	1.3206	0.1114	1.0668	9.840	2.215	
1.0706	1.8345	0.0713	1.0783	12.59	1.563	
1.1016	2.703	0.0412	1.1050	18.86	0.873	
1.1295	3.4372	0.0256	1.1341	25.16	0.576	
			1.1645	31.57	0.384	

Ba BARIUM

THE SYSTEM BARIUM NITRATE - BARIUM HYDROXIDE - WATER AT 25°
(Parsons and Carson, 1910)

Sp. Gr. Sat. Sol.	Gms. per 100 Gms. H ₂ O		Solid Phase
	Ba(OH) ₂	Ba(NO ₃) ₂	
1.0512	4.29	0	Ba(OH) ₂ ·8H ₂ O
1.0651	4.35	1.88	"
1.0790	4.48	4.37	"
1.0975	4.40	5.66	"
1.1220	4.72	7.55	"
1.1371	4.93	10.21	Ba(OH) ₂ ·8H ₂ O
1.1448	5.02	11.48	" + Ba(NO ₃) ₂
1.1210	3.22	11.04	Ba(NO ₃) ₂
1.1002	1.55	10.66	"
1.0797	0	10.30	"

NO

THE SYSTEM BARIUM NITRATE - POTASSIUM NITRATE - WATER
(Glasstone and Riggs, 1925 (25°, 50°); Findlay, Morgan and Morris, 1914
(9.1°, 21.1°, 25°, 35°); Euler, 1904 (17°, 21.5°, 30°, 50°);
Foote, 1904 (25°))a = Ba(NO₃)₂.2b.a = 2KNO₃·Ba(NO₃)₂.b = KNO₃.

t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase	t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	Ba(NO ₃) ₂	KNO ₃			Ba(NO ₃) ₂	KNO ₃	
9.1	6.25	0.0	a	25	5.49**	16.30	2b.a
	4.20	8.15	a + 2b.a		4.88*	17.14	2b.a
	1.98	12.02	2b.a		3.04**	21.99	2b.a
	0.98	16.80	b + 2b.a		2.44*	27.67	2b.a
	0.0	16.76	b		2.04**	27.76	b + 2b.a
17	6.31	11.09	a + 2b.a	30 35	0.0*	27.39	b
	8.46	0.0	a		7.46	17.95	a + 2b.a
21.1	7.47	2.12	a		11.39	0.0	a
	6.35	5.98	a		8.18	12.99	a
	6.06	8.47	a		8.08	17.48	a
	5.98	13.24	a + 2b.a		8.42	19.75	a + 2b.a
	3.35	18.24	2b.a		5.85	24.00	2b.a
	2.30	21.47	2b.a		5.02	26.05	2b.a
	1.76	24.86	b + 2b.a		3.02	34.87	b + 2b.a
	0.0	24.77	b		1.77	34.89	b
	21.5	6.09	a + 2b.a		0.0	35.01	b
	25	9.28*	a				
		7.72*	a				
		6.57*	a				
		6.6*	a + 2b.a				
		6.62†	a + 2b.a				

(Cont.)

*Glasstone and Riggs, 1925

†Foote, 1904

**Findlay, Morgan and Morris, 1914 } at 25°

THE SYSTEM BARIUM NITRATE - POTASSIUM NITRATE - WATER--Cont.

t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase	t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase	
	Ba(NO ₃) ₂	KNO ₃			Ba(NO ₃) ₂	KNO ₃		
50	14.63	0.0	a	50	10.16	30.08	2b.a	
	12.73	3.93	a		6.99	35.75	2b.a	
	10.92	10.53	a		5.64	40.31	2b.a	
	10.14	18.76	a		5.11	44.66	2b.a + b	
	10.43	24.14	a		4.22	44.88	b	
	10.81	28.86	a + 2b.a		2.34	45.45	b	NO
	(10.80)	(29.48)	a + 2b.a					

() Euler, 1904 at 50°.

THE SYSTEM BARIUM NITRATE - SODIUM NITRATE - WATER

B = Ba(NO₃)₂ N = NaNO₃

Results at 0° (Coppadoro, 1912)			Results at 20° (Findlay and Cruickshank, 1926)			Results at 30° (Coppadoro, 1913)		
Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
Ba(NO ₃) ₂	NaNO ₃		Ba(NO ₃) ₂	NaNO ₃		Ba(NO ₃) ₂	NaNO ₃	
4.33	0.41	B	3.89	5.61	B *	10.33	0	B
3.34	1.68	B	2.49	14.59	B	8.58	2.33	B
2.50	3.54	B	2.07	37.07	B	5.28	7.09	B
1.60	8.02	B	1.86	45.74	B + N	3.89	12.07	B
1.56	12.71	B				3.54	14.41	B
1.53	20.24	B				3.20	17.87	B
1.56	27.74	B				3.07	19.06	B
1.55	30.81	B				2.81	23.55	B
1.49	35.83	B				2.27	41.22	B
1.55	40.85	B + N*				2.11	48.22	B + N
1.55	41.30	B + N**				1.00	48.50	N
1.54	42.06	B + N***				0	49.16	N
0.51	41.68	N						

*Ba(NO₃)₂ + 2% NaNO₃
 **Ba(NO₃)₂ + 73.8% NaNO₃
 ***Ba(NO₃)₂ + 97.4% NaNO₃

Ba BARIUM

THE SYSTEM BARIUM NITRATE - AMMONIUM NITRATE - WATER AT 30°
(deBaar, 1918)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ba(NO ₃) ₂	NH ₄ NO ₃		Ba(NO ₃) ₂	NH ₄ NO ₃	
0.0	70.1	NH ₄ NO ₃	4.85	42.17	Ba(NO ₃) ₂
3.71	67.18	"	4.82	41.70	"
4.02	66.81	" + Ba(NO ₃) ₂	4.23	21.82	"
4.62	59.27	Ba(NO ₃) ₂	5.09	9.95	"
4.83	52.39	"	10.4	0.0	"

NO

THE SYSTEM NH₄NO₃ + Ba(NO₃)₂ + AgNO₃ + H₂O AT 30°
(daBaar, 1918)

Gms. per 100 gms. sat. sol.			Solid Phase
AgNO ₃	NH ₄ NO ₃	Ba(NO ₃) ₂	
6.45	62.79	3.53	NH ₄ NO ₃ + Ba(NO ₃) ₂
14.13	57.91	3.10	" "
38.34	34.70	2.15	" "
49.50	26.94	1.74	D + "
61.60	15.08	1.90	" "
67.31	6.17	2.33	Ba(NO ₃) ₂ + AgNO ₃
13.66	59.38	1.97	" "
43.45	32.82	1.32	NH ₄ NO ₃
66.15	8.63	1.04	D
35.49	30.58	3.88	Ba(NO ₃) ₂

D = AgNO₃·NH₄NO₃THE SYSTEM BARIUM NITRATE - CALCIUM NITRATE - WATER
(Uspenskaya and Bergman, 1955)

mole% of dissolved salts		moles H ₂ O per mole of dissolved salts in solution			Solid Phase
Ba(NO ₃) ₂	Ca(NO ₃) ₂	80°	100°	120°	
100.0	0.0	66.03	41.36	32.29	Ba(NO ₃) ₂
41.49	28.51	...	40.67	...	"
59.51	40.49	...	37.72	28.63	"
48.57	51.43	47.52	33.41	26.46	"
29.53	70.47	40.22	28.07	22.31	"
21.19	78.81	35.16	25.08	19.82	"
13.58	86.42	26.57	19.81	15.79	"
6.54	93.46	20.50	13.85	10.30	"
3.68	96.32	8.944	6.201	5.000	"
0.0	100.0	1.423	1.402	1.379	Ca(NO ₃) ₂

THE SYSTEM BARIUM NITRATE - LEAD NITRATE - WATER
Continuous solid solutions are formed

Results at 25°

Data of Fock, 1897; Euler, 1904
(These authors also give data at
15°, 30°, and 47°)

Data of Glasstone and
Riggs, 1925

Sp. Gr. Sat. Sol.	Gms. per Liter		Solid Phase Mol. % Ba(NO ₃) ₂	Gms. per 100 gms. sat. sol.		Solid Phase %Pb(NO ₃) ₂	NO
	Ba(NO ₃) ₂	Pb(NO ₃) ₂		Pb(NO ₃) ₂	Ba(NO ₃) ₂		
1.079	102.2	0.0	100	1.63	8.64	3.59	
1.088	54.9	17.63	98.30	6.26	7.31	10.42	
1.108	86.5	49.80	96.74	8.96	6.66	15.44	
1.119	79.7	68.10	94.80	16.21	5.29	...	
1.140	77.0	97.20	93.62	22.73	4.23	39.27	
1.163	69.8	130.7	92.49	31.13	2.65	76.56	
1.198	66.0	177.3	90.07	34.60	1.39	87.54	
1.252	57.5	247.7	83.47				
1.294	25.9	334.3	75.44				
1.376	28.8	429.7	35.11				
1.459	0.0	553.8	0.0				

Results at 50°
(Glasstone and Riggs, 1925)

Gms. per 100 gms. sat. sol.		Solid Phase %Pb(NO ₃) ₂	Gms. per 100 gms. sat. sol.		Solid Phase %Pb(NO ₃) ₂
Pb(NO ₃) ₂	Ba(NO ₃) ₂		Pb(NO ₃) ₂	Ba(NO ₃) ₂	
5.72	12.68	6.67	29.31	6.32	41.25
10.34	11.05	8.78	37.78	3.83	69.02
17.05	9.12	..	40.82	2.57	88.31

The distribution of small amounts of Barium Nitrate between aqueous solutions and crystals of Lead Nitrate and of Strontium Nitrate, as determined by means of radio active indicators, is described by Polessitsky, 1933, 1935.

SOLUBILITY OF BARIUM NITRATE IN ORGANIC SOLVENTS

Solvent

Methanol ($d_{4}^{25} = 0.78661$)

(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928)

t°	Gms. Ba(NO ₃) ₂ per 100 CH ₃ OH	t°	Gms. Ba(NO ₃) ₂ per 100 CH ₃ OH
0	0.070	40	0.048
10	0.065	50	0.042
20	0.057	60	0.040
30	0.052		

Ba BARIUM

SOLUBILITY OF BARIUM NITRATE IN ORGANIC SOLVENTS—Cont.

Solvent

Ethanol (aq.) at 20° 100 gms. of 50 wt.% aqueous ethanol dissolve
1.0 gms. Ba(NO₃)₂. (Wright, 1927).

at 25° (D'Ans and Siegler, 1913)

Data are also given (in gms. per 100 cc.) by Vogel, 1903.

NO	Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. per 100 Gms. Sat. Sol.		Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. per 100 Gms. Sat. Sol.	
		C ₂ H ₅ OH	Ba(NO ₃) ₂		C ₂ H ₅ OH	Ba(NO ₃) ₂
	0	0	9.55	58	57	1.85
	10.25	9.5	7.63	78.7	78.2	0.62
	18.6	17.5	6.02	90.1	89.9	0.18
	25.05	23.7	5.25	99.4	99.39	0.005
	40.2	38.3	3.53	100*	99.998	0.0016
						0.0020

*(Ferner and Mellon, 1934)

at 100° 100 gms. of 50 wt.% aqueous ethanol dissolve
4.65 gms. Ba(NO₃)₂. (Wright, 1927).

iso-Propanol at 25° 100 gms. isopropanol dissolve 0.0016–0.0020 gms.
Ba(NO₃)₂. (Ferner and Mellon, 1934).

Acetic acid at 25° 100 gms. pure acetic acid dissolve 0.00217 gms.
Ba(NO₃)₂. (Davidson and Geer, 1933).

Acetone at 25° * 100 gms. acetone dissolve 0.005 gms. Ba(NO₃)₂.
(D'Ans and Siegler, 1913).

Phenol(aq.) at 25° (Rothmund and Wilsmore, 1902; see also
Timmermans, 1907).

		Gms. per Liter Sat. Sol.		Gms. per Liter Sat. Sol.	
		C ₆ H ₅ OH	Ba(NO ₃) ₂	C ₆ H ₅ OH	Ba(NO ₃) ₂
		0.0	100.2	29.12	91.31
		4.23	98.97	37.73	88.90
		7.71	97.95	47.11	86.26
		13.73	95.81	68.45	81.00
Furfural	at 25°	100 gms. of a sat'd. sol'n. in furfural contains 0.01 gm. Ba(NO ₃) ₂ . (Trimble, 1941).			

SOLUBILITY OF BARIUM NITRATE IN ABSOLUTE ETHYL ALCOHOL
IN THE PRESENCE OF AMMONIUM BROMIDE AT 25°
(Seward and Schumb, 1930)

Gm. Mols. per liter $\times 10^5$		Gms. per liter	
NH_4Br	$\text{Ba}(\text{NO}_3)_2$	NH_4Br	$\text{Ba}(\text{NO}_3)_2$
0.0	0.99	0.0	0.00259
20.3	1.43	0.0199	0.00374
33.0	1.70	0.323	0.00444
65.8	2.10	0.0645	0.00549

SOLUBILITY OF BARIUM NITRATE IN VARIOUS INORGANIC SOLVENTS

NO

Solvent

Anhyd. Ammonia

(Portnow and Wasailew, 1925;
Portnow and Sahurawlew, 1935)

At the lower temperatures ammoniates of the
probable composition $\text{Ba}(\text{NO}_3)_2 \cdot 4\text{NH}_3$ and $\text{Ba}(\text{NO}_3)_2 \cdot 8\text{NH}_3$
are believed to be formed.

Note the disagreement among various authors.

t°	Gms. $\text{Ba}(\text{NO}_3)_2$ per 100 gms. NH_3	t°	Gms. $\text{Ba}(\text{NO}_3)_2$ per 100 Gms. NH_3
-27	5.14	* +2.5	36.24
-15.5	11.57	8.7	51.40
-9	13.80	12.7	67.60
-7	16.88	22.0	105.8
-0.5	27.84		
(0)	(17.88*)	(25)	(97.22**)
+0.5	28.71	51.0	194.8

*Linhard and Stephan, 1933, 1934. **Hunt and Boncyk, 1933.

Hydrazine 100 cc. anhydrous hydrazine dissolve 3 gms. $\text{Ba}(\text{NO}_3)_2$
at room temp. (Welsh and Brodersen, 1915).

Hydroxylamine 100 gms. hydroxylamine dissolve 11.4 gms. $\text{Ba}(\text{NO}_3)_2$
at 17°-18°. (de Bruyn, 1892).

Melting point data are given for the following:

$\text{Ba}(\text{NO}_3)_2 + \text{Ca}(\text{NO}_3)_2 + \text{KNO}_3$ (1)	$\text{Ba}(\text{NO}_3)_2 + \text{KNO}_3 + \text{NaNO}_3$ (4)(6)
" + KNO_3 (2)(3)(4)(6)(7)	" + LiNO_3 (4)
" + " + LiNO_3 (4)	" + NaNO_3 (2)(3)(4)(6)(8)
" + " + $\text{Sr}(\text{NO}_3)_2$ (2)	" + " + NH_4NO_3 (5)

(1) Labourn and Madgin, 1933; (2) Labourn, Madgin and Freeman, 1834; (3) Ricci, 1937; (4) Harkins and Clarke, 1915; (5) Campbell and Campbell, 1947; (6) Protzenko and Bergman, 1951; (7) Markowitz, Ricci and Winternitz, 1955; (8) Speranskaya, 1943.

Ba BARIUM

NbO BARIUM NIOBATE $Ba(NbO_3)_2$

At 15°, one liter of saturated solution in water contains 0.00459 gms. $Ba(NbO_3)_2 \cdot 3H_2O$. (Krylor and Alekseev, 1955).

O BARIUM OXIDE BaO

OH BARIUM HYDROXIDE $Ba(OH)_2$

SOLUBILITY IN WATER
(Rosenthal and Ruhlman, 1870)

More recent investigators are in agreement at 25, 45, and 75°. At 30°, Van Meurs (1916) found 5.34 wt.%, Schreinemakers (1909-10), 5.58 wt.%, and Carlson, Chacones and Wells (1950), 5.29 gms. per 100 cc. sat. sol., all somewhat higher than the value listed below.

Data are given by Sill (1916), for the influence of pressures up to 490 kgs. per sq. cm. on the solubility of $Ba(OH)_2 \cdot 8H_2O$ in H_2O at 25°.

Solid Phase $Ba(OH)_2 \cdot 8H_2O$

t°	Gms. $Ba(OH)_2$ per 100 Gms.		t°	Gms. $Ba(OH)_2$ per 100 Gms.	
	Water	Solution		Water	Solution
0	1.67	1.65	30	5.59	5.29
5	1.95	1.92	40	8.22	7.60
10	2.48	2.42	50	13.12	11.61
15	3.23	3.13	60	20.94	17.32
20	3.89	3.74	75	63.51	38.85
25	4.68	4.47	80	101.40	50.35

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE
(Scholder and Patsch, 1935)

Results at 20°

The saturated solutions were prepared by constant agitation for 7 to 14 days, in closed nickel plated vessels. The excess solid phase was removed by filtration in an atmosphere of nitrogen. An excess of standard HCl was added and this back titrated with standard NaOH. Barium was determined as sulfate. The accuracy of Schreinemakers' identification of the solid phases (below) is questioned and repeated determinations at 25° and 30° are suggested.

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS
OF SODIUM HYDROXIDE--Cont.

Normality of Aq. NaOH	Gms. BaO per 100 cc. sat. sol.	Solid Phase	Normality of Aq. NaOH	Gms. BaO per 100 cc. sat. sol.	Solid Phase
0.0	3.470	BaO·9H ₂ O	11.07	0.966	BaO·9H ₂ O
0.56	1.473	"	11.28	1.064	"
0.97	0.942	"	11.64	1.317	"
1.34	0.706	"	11.78	1.598	"
1.80	0.549	"	12.25	1.687	BaO·5H ₂ O
2.34	0.443	"	13.6	1.543	"
3.19	0.328	"	14.0	1.494	BaO·2½H ₂ O
3.75	0.292	"	14.8	1.102	"
4.57	0.247	"	14.9	1.081	"
5.70	0.241	"	16.5	0.714	"
7.0	0.244	"	17.0	0.675	"
7.92	0.274	"	18.9	0.641	BaO·2H ₂ O
9.17	0.386	"	19.2	0.638	"
9.9	0.553	"	19.4	0.645	"

The authors also give analyses of the solid phases in contact with solutions of 12.9-18.0 normal NaOH at 30° which show that only BaO·2½H₂O is present instead of the hydrates BaO·4H₂O and BaO·2H₂O reported by Schreinemakers (below).

Results at 25°
(Neale and Stringfellow, 1932)

Gm. Equiv. per liter		Gm. Equiv. per liter	
NaOH	Ba(OH) ₂	NaOH	Ba(OH) ₂
0.0	0.545	0.9177	0.1727
0.4417	0.3052	1.230	0.1211
0.6135	0.2445	1.837	0.084

Results at 30°
(Schreinemakers, 1909-10)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
BaO	Na ₂ O		BaO	Na ₂ O	
4.99	0	BaO·9H ₂ O	1.84	26.14	BaO·4H ₂ O
1.29	4.78	"	1.75	27.72	"
0.89	6.43	"	1.58	28.43	"
0.57	9.63	"	1.34	29.24	" + BaO·2H ₂ O
0.53	11.62	"	0.82	32.12	BaO·2H ₂ O
0.47	17.87	"	0.59	34.72	"
1.06	23.28	"	0.57	51.09	" + NaOH·H ₂ O
1.87	24.63	BaO·9H ₂ O + BaO·4H ₂ O	0	+42	NaOH·H ₂ O

Ba BARIUM

THE SYSTEM BARIUM HYDROXIDE - BARIUM HYDROSULFIDE - WATER
(Tarres and Bruckner, 1920)

Note.—These results, when plotted on cross section paper, yield curves composed of three branches. The central branch of each curve corresponds to the double salt $\text{Ba}(\text{OH})_2 \cdot \text{Ba}(\text{SH})_2 \cdot 10\text{H}_2\text{O}$.

	t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.	
		$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{SH})_2$		$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{SH})_2$
OH	0...	1.49	0.92	40...	1.29	35.2
	0...	0.88	5.45	60...	12.9	1.15
	0...	0.6	13.6	60...	11.0	7.82
	0...	0.6	19.6	60...	8.0	10.03
	0...	0.65	26.3	60...	5.38	12.25
	0...	0.69	22.5	60...	3.0	19.9
	0...	0.65	27.8	60...	2.56	27.0
	0...	0.70	28.6	60...	2.52	28.8
	0...	0.60	29.0	60...	2.13	33.0
	0...	0.96	32.6	60...	2.10	33.5
	20...	3.0	4.87	60...	2.06	37.2
	20...	2.85	6.20	80...	22.3	1.81
	20...	1.03	15.60	80...	19.0	5.55
	20...	1.08	17.90	80...	18.5	9.6
	20...	1.00	29.00	80...	9.0	12.4
	20...	1.95	17.1	80...	6.0	21.0
	20...	1.1	26.2	80...	4.6	25.0
	20...	1.0	29.0	80...	4.0	30.0
	20...	0.9	30.0	80...	4.3	31.4
	20...	1.18	32.8	80...	3.7	34.95
	40...	4.65	4.5	80...	2.05	39.0
	40...	3.8	9.55	100...	41.9	1.32
	40...	1.9	15.3	100...	30.5	7.1
	40...	1.5	20.4	100...	29.5	7.6
	40...	1.5	27.5	100...	27.3	11.9
	40...	1.65	17.6	100...	24.4	13.0
	40...	1.44	20.7	100...	5.8	35.2
	40...	1.39	25.1	100...	5.0	41.8
	40...	1.32	30.6	100...	1.96	43.7

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF ALKALI
CHLORIDES AT 25°
(Hers, 1910)

In Lithium Chloride Gms. per 100 cc. Sat. Sol.		In Potassium Chloride Gms. per 100 cc. Sat. Sol.		In Rubidium Chloride Gms. per 100 cc. Sat. Sol.		In Sodium Chloride Gms. per 100 cc. Sat. Sol.	
LiCl	$\text{Ba}(\text{OH})_2$	KCl	$\text{Ba}(\text{OH})_2$	RbCl	$\text{Ba}(\text{OH})_2$	NaCl	$\text{Ba}(\text{OH})_2$
9.75	11.45	25.95	5.93	15.11	5.55	16.51	6.91
6.02	8.03	13.05	5.66	0	4.76	8.37	5.99
3.18	6.39	8.60	5.53	...	..	4.27	5.40
0	4.76	0	4.76	...	..	0	4.76

Ba BARIUM

THE SYSTEM BARIUM HYDROXIDE - PHENOL - WATER AT 25°
(Van Meurs, 1916)

Mols. per 100 mols. sat. sol.			Mols. per 100 mols. sat. sol.		
C_6H_5OH	$\frac{Ba(OH)_2}{2}$	Solid Phase	C_6H_5OH	$\frac{Ba(OH)_2}{2}$	Solid Phase
0.0	0.99	$Ba(OH)_2 \cdot 8H_2O$	14.44	5.89	$(C_6H_5O)_2Ba \cdot 4H_2O$
0.76	1.54	"	19.25	6.70	"
1.48	2.19	"	33.57	7.53	"
2.51	3.09	"	50.25	7.06	"
3.06	3.63	" + $(C_6H_5O)_2Ba \cdot 4H_2O$	69.61	4.98	"
OH 3.17	3.29	$(C_6H_5O)_2Ba \cdot 4H_2O$	70.74	5.04	"
4.78	3.67	"	70.36	4.94	"
12.03	5.44	"	73.48	3.28	"

Two liquid layers are formed at concentrations of $Ba(OH)_2$ less than 0.56 mol. %.

Aqueous layer		Phenol layer	
Mol. % C_6H_5OH	Mol. % $\frac{Ba(OH)_2}{2}$	Mol. % C_6H_5OH	Mol. % $\frac{Ba(OH)_2}{2}$
1.79	0.0	32.33	0.0
1.89	0.05	28.84	0.12
2.48	0.20	19.82	0.47
3.70	0.30	14.46	0.56

THE SYSTEM BARIUM HYDROXIDE - RESORCINOL - WATER AT 30°
(Van Meurs, 1916)

Mols. per 100 mols. sat. sol.		Mols. per 100 mols. sat. sol.			
$\frac{C_6H_5(OH)_2}{2}$	$\frac{Ba(OH)_2}{2}$	$\frac{C_6H_5(OH)_2}{2}$	$\frac{Ba(OH)_2}{2}$	Solid Phase	
0.0	1.17	18.00	14.45	$Ba(OH)_2 \cdot 8H_2O$	$C_6H_4O_2Ba \cdot 2H_2O$
2.45	3.42	20.44	14.21	"	"
4.37	5.29	47.75	10.42	"	$C_6H_4(OH)_2$
5.77	6.62	43.63	6.86	"	"
9.40	10.38	40.71	3.30	"	"
13.96	14.56			" + $C_6H_4O_2Ba \cdot 2H_2O$	

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS ACETONE AT 25°
(Herz and Knoch, 1904)

Sp. Gr. of Solutions	Vol. % Acetone	Ba(OH) ₂ per 100 cc. Sat. Solution		Gms. Ba(OH) ₂ per 100 Gms. Solution
		Millimola.	Grams	
1.0479	0	55.08	4.722	4.506
1.0168	10	31.84	2.730	2.686
0.9927	20	17.79	1.525	1.536
0.9763	30	9.10	0.779	0.798
0.9561	40	4.75	0.407	0.426
0.9398	50	1.54	0.132	0.141
0.9179	60	0.48	0.041	0.045
0.8956	70	0.08	0.007	0.018

OH

SOLUBILITY OF Ba(OH)₂ IN FURFURAL

100 gms. of saturated solution of Barium Hydroxide in furfural contains 9.0 gms. Ba(OH)₂·8H₂O. (Trimble, 1941).

Data for the solubility of BaO in molten LiCl, Li₂SO₄, Na₂SO₄, KCl and NaCl are given by Voskresenskaya and Kacheev, 1954.

Melting point data have been determined for the following:

BaO + BaCO₃ (Lander, 1951)
 BaO + Bi₂O₃ + O (Aurivillius, 1943)
 BaO + BeO (Geller, Yavorsky, Steierman, Creamer, 1946)
 BaO + CaCl₂ (Sackur, 1911-12)
 BaO + MgO (v. Wartenberg and Prophet, 1932)
 BaO + SiO₂ (Eskola, 1922; Grieg, 1927; Austin, 1947)
 BaO + SiO₂ + Na₂O (Kumanin, 1940) and in part by (Greene and Morgan, 1941)
 BaO + SrCl₂ (Sackur, 1911-12)
 BaO + ZrO₂ (v. Wartenberg and Werth, 1930)

Data for the solubility of BaO in molten LiCl, Li₂SO₄, Na₂SO₄, KCl and NaCl are given by Voskresenskaya and Kachev, 1954.

Ba(OH)₂ + BaBr₂ (Seward, 1945)
 Ba(OH)₂ + BaCO₃ (")
 Ba(OH)₂ + BaCl₂ (")
 Ba(OH)₂ + NaOH (")

Ba BARIUM

PO BARIUM PHOSPHATES $Ba_3(PO_4)_2$
 $BaHPO_4$
 $Ba(H_2PO_4)_2$

THE SYSTEM $BaO - P_2O_5 - H_2O$ AT 25°
 (Tartar and Lorah, 1929; Guerin and Artur, 1952; Artur, 1955)

Data in parentheses are those of Artur, 1955.

d_{25} of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d_{25} of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	BaO	P_2O_5			BaO	P_2O_5	
(*)	(0.0013)	(0.0047)	$3^\circ + 2^\circ$	1.354	10.86	23.46	$2^\circ + 1^\circ$
(**)	(0.019)	(0.017)	2°	(****)	(11.4)	(21.4)	$2^\circ + 1^\circ$
1.040	2.00	2.96	"	...	(10.8)	(22.65)	1°
...	(3.25)	(5.3)	"	1.397	9.14	28.36	"
1.085	3.66	5.95	"	1.420	7.41	32.68	"
1.107	4.33	7.61	"	1.425	6.93	33.74	"
1.118	4.80	8.25	"	1.483	2.72	44.34	"
1.165	6.31	11.19	"	1.524	1.50	49.28	"
1.166	6.09	11.36	"	1.561	1.02	52.61	"
(***)	(6.3)	(11.65)	"	1.580	0.85	53.79	"
1.188	6.84	12.35	"	...	(0.60)	(56.0)	"
1.246	8.50	16.51	"	...	(0.55)	(65.3)	"

$1^\circ = Ba(H_2PO_4)_2$ $2^\circ = BaHPO_4$ $3^\circ = Ba_3(PO_4)_2$

* pH = 7.2 ** pH = 5.7 *** pH = 1.4 **** pH = 1.0

THE SYSTEM $BaO - P_2O_5 - H_2O$ AT 38°
 (Holt, Pierce and Kajdi, 1954)

pH	Sat. Sol.		Solid Phase Ba/P Ratio	pH	Sat. Sol.		Solid Phase Ba/P
	moles Ba per liter $\times 10^3$	moles P per liter $\times 10^3$			moles Ba per liter $\times 10^3$	moles P per liter $\times 10^3$	
4.76	4.24	8.39	4.15	5.94	0.877	1.61	4.34
4.84	3.21	6.34	4.45	6.33	0.702	1.15	4.37
4.79	2.87	5.60	4.28	6.69	0.513	0.789	4.49
5.28	2.46	4.63	4.41	6.95	0.291	0.388	4.53
5.23	1.46	3.38	4.40	7.25	0.258	0.198	5.42
5.41	1.79	3.30	4.42				

EQUILIBRIUM IN THE SYSTEM $Ba(OH)_2 + H_3PO_4 + CO_2 + H_2O$ AT 17°
 (Pallu, 1929)

The author mixed in different proportions, a 0.248 normal solution of $Ba(OH)_2$ and a 0.248 normal solution of H_3PO_4 and bubbled CO_2 through 100 cc. portions of these mixtures for about a month. He measured the conductivities of the solutions at 17° and finally analyzed the saturated solutions and precipitates. The solid phase in contact with the solutions composed of up to two thirds $Ba(OH)_2$ and one third H_3PO_4 was the secondary barium phosphate. With greater amounts of $Ba(OH)_2$ the solid phase was a mixture of secondary barium phosphate and $BaCO_3$.

BARIUM Pyro PHOSPHATE $\text{Ba}_2\text{P}_2\text{O}_7$

PO

Data for the solubility of Barium Pyrophosphate in aqueous solutions of hydrogen peroxide are given by Munsberg, 1928.

BARIUM Organic PHOSPHATES

PO

SOLUBILITY OF EACH IN WATER
(Baillly, 1916, 1919; Baillly and Gaume, 1924)

Note.—In these experiments constant agitation was not employed and the variations in results for the several forms and for different preparations of the same form, are probably due to lack of equilibrium.

Compound	Formula	t°	Gms. per 100 gms. sat. sol.	
			Anhydrous compd.	Hydrated compd.
Neutral barium methyl phosphate	BaCH ₂ ·PO ₄ ·H ₂ O	10	2.54	2.72
" " " "	"	15	..	2.02(Cavalier)
" " " "	"	50	1.05	1.12
" " " "	"	100	0.39	0.42
Acid " " " "	Ba(CH ₂ ·HPO ₄) ₂ ·H ₂ O	17	23.50	24.68
Barium ethyl phosphate	BaC ₂ H ₅ ·PO ₄ ·6H ₂ O	20	..	6.72(Pelouze)
" propyl "	BaC ₃ H ₇ ·PO ₄ ·2H ₂ O	20	..	8.08(Cavalier)
" isopropyl "	BaCH(CH ₃) ₂ ·PO ₄ ·2H ₂ O	16	..	3.52
" isobutyl "	BaCH ₂ CH(CH ₃) ₂ ·PO ₄ ·2H ₂ O	24	..	5.65
" allyl "	BaCH ₂ ·CH = CH ₂ PO ₄	15	12.0	..
Barium α glycerophosphate	BaC ₂ H ₃ (OH) ₂ PO ₄ · $\frac{1}{2}$ H ₂ O	13	1.4*	..
" " " "	"	16	1.87	..
" " " "	"	22	1.28**	..
" β " " "	"· $\frac{1}{2}$ H ₂ O	12	5.8*	..
" " " (cryst.)	"	18	3.58	..
" " " " "	"	21	4.31	..
" " " " "	"·H ₂ O	21	5.25	..
" " " (amorph.)	"	soluble in all proportions		
Neutral barium glycerophosphate	BaPO ₄ ·C ₂ H ₄ OH·H ₂ O	16	6.27	..
" " " " "	"	55	3.50	..
Acid " " " "	Ba(PO ₄ ·HC ₂ H ₄ OH) ₂ ·3H ₂ O	deliquescent		
Barium "Glycerolphosphate"	BaC ₃ H ₅ O ₆ P· $\frac{1}{2}$ H ₂ O	21	8.4***	..
" "di Glycerolphosphate"	.....	22	3.76***	..
Barium Glycerolphosphate	BaC ₃ H ₇ O ₆ P·H ₂ O	21	4.5***	..
" acetone " "	BaC ₆ H ₁₁ O ₆ P·3H ₂ O	25	3.51**	..

* - (King and Pyman, 1914). ** - (Fischer and Pfahler, 1920). *** - (Langheld and Oppmann, 1912). **** - (Rogier and Fiore, 1913).

BARIUM Per RHENATE $\text{Ba}(\text{ReO}_4)_2$

ReO

One liter sat. solution in water contains about 150 gms. $\text{Ba}(\text{ReO}_4)_2$ at 20°. (Noddaek, 1929).

One liter of 89.7 percent ethyl alcohol dissolve 2.45 gms. $\text{Ba}(\text{ReO}_4)_2$ at 18.5°. (Tolbert, 1932).

Ba BARIUM

S BARIUM SULFIDE BaS

SOLUBILITY OF BARIUM SULFIDE IN WATER
(Chorower, 1941)

The author discusses the reaction $2\text{BaS} + 2\text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{Ba}(\text{SH})_2$ and concludes that the best separation of the products $\text{Ba}(\text{OH})_2$ and $\text{Ba}(\text{SH})_2$ can be made at 80° when the solubilities $\text{BaO} : \text{BaS}$ are in the ratio 31:20. .

t°	Gms. BaS per 100 gms.		t°	Gms. BaS per 100 gms.	
	Sat. Sol.	H ₂ O		Sat. Sol.	H ₂ O
0	2.80	2.88	60	21.69	27.69
5	3.56	3.69	65	24.57	32.57
10	4.66	4.89	70	27.19	37.35
15	5.93	6.30	75	30.33	43.53
20	7.28	7.86	80	33.29	49.91
25	8.22	8.95	85	36.60	57.72
30	9.40	10.38	90	40.24	67.34
40	12.96	14.89	95	39.14	64.30
45	15.33	18.11	100	37.61	60.29
50	17.62	21.39	103	37.70	60.51
55	19.57	24.33			

SOLUBILITY OF COMMERCIAL BARIUM SULFIDE IN WATER
(Terres and Bruckner, 1920)

The sample of barium sulfide contained 87.2% BaS, 4.33% $\text{Ba}(\text{OH})_2$ and 8.47% Fe and Mn oxides. Due to the oxidizing action of air upon the sulfhydrate the solubility determinations were conducted in an atmosphere of hydrogen. The mixtures were constantly agitated for many hours.

t°	Gms. per 100 gms. sat. sol.		Corresponding BaS in solution	Solid Phase changed in Composition between	
	Ba(OH) ₂	Ba(SH) ₂			
0	2.05	2.42	4.03	44.24% BaS	14.2% BaO
20	3.28	3.90	6.48	....	....
40	5.32	6.32	10.5	....	....
60	8.14	9.68	16.5	....	....
80	10.62	12.61	21.0	....	....
100	12.80	15.25	25.25	39.0% BaS	19.5% BaO

Fusion point data for certain regions of the system BaS + S are given by Robinson and Scott, 1931.

The reaction of BaS + Cu₂O at 700° was studied by Schenck and Keuth, 1940.

BARIUM Hydrogen SULFIDE $\text{Ba}(\text{SH})_2$

SH

SOLUBILITY IN WATER
(Terres and Bruckner, 1920)

t°	Gms. $\text{Ba}(\text{SH})_2$	t°	Gms. $\text{Ba}(\text{SH})_2$
	per 100 gms. sat. sol.		per 100 gms. sat. sol.
-15	32.0*	60	36.2
0	32.6	80	39.0
20	32.8	100	43.7
40	34.5		

Data of Bezuglyi and Kutsakov, 1939.

At 20°, a solution saturated with $\text{Ba}(\text{SH})_2 + \text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ contains 22.3% $\text{Ba}(\text{SH})_2$ and 14.0% (by wt.) BaCl_2 .At 20°, a solution saturated with $\text{Ba}(\text{SH})_2 + \text{NaHS}$ contains 0.15% $\text{Ba}(\text{SH})_2$ and 40.85% (by wt.) NaHS .Data are given for the quaternary system $\text{Ba}(\text{SH})_2 + 2\text{NaCl} \rightleftharpoons 2\text{NaHS} + \text{BaCl}_2$.BARIUM SULFITE BaSO_3

SO

SOLUBILITY IN WATER AND IN AQUEOUS SUGAR SOLUTIONS
(Rogowicz—Z. Ver Zuckerind, 938, 1905)

Conc. of Sugar Sol.	Gm. BaSO_4 per 100 cc. Sol.		Conc. of Sugar Sol.	Gm. BaSO_4 per 100 cc. Sol.	
	at 20°	at 80°		at 20°	at 80°
0° Baume	0.0197	0.00177	40° Baume	0.0048	0.00158
10° "	0.0104	0.00335	50° "	0.0030	0.00149
20° "	0.0097	0.00289	60° "(sat.)	0.0022	0.00112
30° "	0.0078	0.00223	...	..	...

BARIUM SULFATE BaSO_4

SO

SOLUBILITY IN WATER

(Kohlrausch, 1908; Melcher, 1910; Neuman, 1933;
Ruff, 1929; Kolthoff and Vogelenzang, 1919; Lemarchands, 1928)

t°	Gms. BaSO_4 per liter sat. sol.	t°	Gms. BaSO_4 per liter sat. sol.
0	0.00115 (K.)	25	0.00223 (N.)
10	0.0020 (K.)	30	0.00285 (K.)
18	0.00226 (K.&V.)	50	0.00336 (M.)
	0.00222 (R.)	100	0.0039 (M.)
20	0.0024 (K.)		0.118 (L.)

(Cont.)

EFFECT OF PARTICLE SIZE AND PURITY ON THE SOLUBILITY

In a discussion of the variation in solubility of BaSO_4 with the size of the grain Balarew, 1925, points out that samples of BaSO_4 precipitated from aqueous solutions with BaCl_2 always contain occluded BaCl_2 which can be present to the extent of one per cent. Due to this source of error he questions the accuracy of Hulett's observations. Samples of BaSO_4 which no longer give a test for chlorides in the wash water, may yield BaCl_2 on prolonged grinding.

Lemarchands, 1928 found that particles smaller than 1.7μ may have a solubility three times that of larger particles. Herovsky and Berezicky, 1929 found the solubility of freshly precipitated BaSO_4 is about 8 times greater than that of a precipitate 30 hours old.

50

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID

Results at 10°

(Castagnov and Larcebau, 1951)

Saturated solutions in known concentrations of H_2SO_4 were prepared at the boiling point, and then cooled and diluted. The $\text{SO}_4 =$ remaining in solution was determined gravimetrically.

Vol. % conc. H_2SO_4 in sat. sol.	20	40	60	80	100
Gms. BaSO_4 per 100 ml. sat. sol.	0.0235	0.0526	0.082	0.182	9.412

Results at 20°

(Von Weimarn, 1911)

Gms. H_2SO_4 per 100 Gms. Solvent	Gms. BaSO_4 per 100 cc. Sat. Sol.	Solid Phase
73.83	0.0030	BaSO_4
78.04	0.0135	"
80.54	0.0285	"
83.10	0.0800	"
84.15	....	" + $\text{BaSO}_4 \cdot \text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
85.78	0.3215	$\text{BaSO}_4 \cdot \text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
88.08	1.2200	"
93.00	....	" + $\text{BaSO}_4 \cdot \text{H}_2\text{SO}_4$
96.17	4.9665	$\text{BaSO}_4 \cdot \text{H}_2\text{SO}_4$
96.46	18.6900	"

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID--Cont.

Results at 25°
(Trenner and Taylor, 1931)

The mixtures were sealed in glass tubes and rotated for seven days. After standing for 24 hours the supernatant liquid was transferred to a Lunge pipette for analysis. The acid was titrated with standard carbonate-free sodium hydroxide using methyl orange as indicator. The sulfate was determined gravimetrically.

The solid phases are probably BaSO_4 and $\text{BaSO}_4 \cdot \text{H}_2\text{SO}_4$ with a transition point at an acid concentration of about 85 percent.

Percent conc. of H_2SO_4 in sat. sol.	Gms. per 100 gms. sat. sol.		Percent conc. of H_2SO_4 in sat. sol.	Gms. per 100 gms. sat. sol.		SO
	H_2SO_4	BaSO_4		H_2SO_4	BaSO_4	
83.25	83.21	0.050	96.70	88.45	8.53	
85.08	84.93	0.203	97.80	87.22	10.95	
85.63	85.50	0.210	97.99	86.54	11.68	
86.10	85.90	0.230	98.12	86.06	12.29	
87.96	87.45	0.486	89.61	86.06	12.79	
92.58	90.75	1.97	98.65	85.57	13.17	
92.91	90.58	2.51	98.91	85.80	13.25	
94.44	90.57	4.10	98.97	85.49	13.62	
94.79	90.40	4.63	99.95	85.27	13.83	
95.19	86.68	5.79	99.47	84.84	14.70	
95.85	89.28	6.86	99.80	84.22	15.61	
96.14	89.13	7.29	99.75	84.05	15.74	
96.08	88.86	7.05	100.00	84.11	15.89	

OTHER DATA ON THE SYSTEM $\text{BaSO}_4 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$

Data for this system are also given by Volkhouskii (1910).

100 cc. sat. solution of BaSO_4 in abs. H_2SO_4 contain 28.51 gms.

BaSO_4 , solid phase = $\text{BaSO}_4 \cdot 30\text{H}_2\text{SO}_4$. (Bergius, 1910).

100 cc. of 97.86 per cent H_2SO_4 constantly agitated with BaSO_4 in a thermostat at 25° for 96 hours contain 14.91 gms. BaSO_4 . (Meyer and Friedrich, 1922).

Huff (1947) found precipitated barium sulfate to be more soluble in solutions containing 0.01 - 0.06 M H_2SO_4 than in pure water, but when 0.15 M H_2SO_4 was present, coprecipitation of the excess sulfate ions during precipitation more than counter balanced the increased solubility.

Ba BARIUM

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC
AND OF NITRIC ACID

Results of Kolthoff and Vogelenzang, 1919

One-half gram of a specially purified sample of BaSO_4 was shaken for 7-8 hours at constant temperature with 250 cc. of the acid solution. After subsidence a sample of the clear filtrate was evaporated in a platinum dish and the residue ignited and weighed.

50	Results for Aq. HCl at:				Results for Aq. HNO_3 at	
	12°		90°		19°	
	Normality of HCl	Gms. BaSO_4 per 1000 cc. sat. sol.	Normality of HCl	Gms. BaSO_4 per 1000 cc. sat. sol.	Normality of HNO_3	Gms. BaSO_4 per 1000 cc. sat. sol.
	0.098	0.011	0.00(=H ₂ O)	0.0070	0.05	0.000(9)
	0.49	0.031	0.05	0.0077	0.10	0.0012
	0.98	0.0538	0.50	0.0265	0.5	0.0039
			1.00	0.0416	1.0	0.0077
					2.0	0.0119

Results of Banthisch, 1884

In Hydrochloric Acid

cc. containing 1 Mg. Equiv. of HCl	Mgs. BaSO_4 per 1 Mg. Equiv. of HCl	Gms. per 100 cc. Solution	
		HCl	BaSO_4
2.	0.133	1.82	0.0067
1.	0.089	3.65	0.0089
0.5	0.056	7.29	0.0101
0.2	0.017	18.23	0.0086

In Nitric Acid

cc. containing 1 Mg. Equiv. of HNO_3	Mgs. BaSO_4 per 1 Mg. Equiv. of HNO_3	Gms. per 100 cc. Solution	
		HNO_3	BaSO_4
2.	0.140	3.15	0.0070
1.	0.107	6.31	0.0107
0.5	0.085	12.61	0.0170
0.2	0.048	31.52	0.0241

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC
AND OF NITRIC ACID--Cont.

Results of Karaoglanow, 1917

A weighed amount of BaSO_4 was boiled in 200 cc. of water or salt solution for 2 hours under a reflux condenser, and allowed to stand 24 hours with frequent shaking. The undissolved residue of BaSO_4 was filtered, washed, ignited and weighed. The amount dissolved in the wash water was determined by a special experiment and a correction made for it. By this method the solubility of BaSO_4 in water was found to be 0.0043 gms. per liter at room temperature.

Similar determinations were made for aqueous solutions of BaCl_2 , H_2SO_4 , KCl , KNO_3 , K_2SO_4 , CaCl_2 , SrCl_2 , $\text{Pb}(\text{NO}_3)_2$, $\text{Fe}_2(\text{SO}_4)_3$, FeCl_3 , HCl , HNO_3 , and various mixtures of these salts and acids. The results obtained for aq. HNO_3 and aq. HCl are as follows:

In Aqueous HNO_3		In Aqueous HCl	
Normality of HNO_3	Gms. BaSO_4 per 1000 cc. sat. sol.	Normality of HCl	Gms. BaSO_4 per 1000 cc. sat. sol.
0.05	0.014	0.00	0.0043
0.10	0.026	0.10	0.010
0.30	0.076	0.30	0.029
0.50	0.124	0.50	0.0047
1.00	0.237	1.00	0.087
2.00	0.393	2.00	0.146

SOLUBILITY OF BaSO_4 IN HBr AND HI SOLUTIONS

100 cc. HBr dissolve 0.04 gm. BaSO_4 ; 100 cc. HI dissolve 0.0016 gm. BaSO_4 at the boiling point. (Haslam, 1886).

SOLUBILITY OF BaSO_4 IN FORMIC ACID SOLUTION

100 cc. of sat. solution of BaSO_4 in 95% formic acid contain 0.01 gm. BaSO_4 at 18.5°. (Aschan, 1913).

Ba BARIUM

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SALT SOLUTIONS

		Results of Newman, 1933 at 25°			
Added Salts	Ionic strength of aq. solvent salt solution	Gm. mols. BaSO ₃ per liter	Ionic strength of aq. solvent salt solution	Gm. mols. BaSO ₄ per liter	
KCl	0.0000	0.957 x 10 ⁻⁵	0.000010 Mg(NO ₃) ₂	1.007 x 10 ⁻⁵	
MgCl ₂	0.000020 KCl	1.002	0.0001199 "	1.098	"
Mg(NO ₃) ₂	0.000263 "	1.067	0.0002856 "	1.172	"
LaCl ₃	0.002526 "	1.274	0.002686 "	1.633	"
La(NO ₃) ₃	0.02631 "	2.090	0.01199 "	2.458	"
SO	0.03501 "	2.320	0.0000067 LaCl ₃	1.003	"
	0.000020 "	1.007	0.0000592 "	1.112	"
	0.0003566 "	1.085	0.0001447 "	1.182	"
	0.002456 "	1.277	0.0002599 "	1.290	"
	0.02252 "	2.010	0.002400 "	2.014	"
	0.03602 "	2.355	0.004296 "	2.394	"
	0.000010 MgCl ₂	1.002	0.0000067 La(NO ₃) ₃	1.003	"
	0.0001198 "	1.035	0.00005923 "	1.112	"
	0.0002856 "	1.167	0.0001447 "	1.182	"
	0.002113 "	1.547	0.0002599 "	1.290	"
	0.006410 "	2.015	0.002374 "	2.037	"
	0.01064 "	2.340	0.004276 "	2.450	"

Results of Fraps, 1901 at 20°-25°

		Milligrams BaSO ₄ per Liter in:		
Gms. Chloride per Liter		Aq. FeCl ₃	Aq. AlCl ₃	Aq. MgCl ₂
FeCl ₃	1	58	33	30
AlCl ₃	2 ¹	72	43	30
MgCl ₂	5 ²	115	60	33
	10	123	94	33
	25	150	116	50
	50	160	170	50
	100	170	175	50

Results of Balcar and Stegman, 1928

ThCl₄ BaCl₂ To solutions of varying concentration of Thorium Chloride, strongly illuminated by a converging beam of light, equivalent solutions of barium chloride and sulfuric acid were added and the point determined at which the Tyndall cone became permanent. This was taken as the point representing saturation of the solution.

Gm. mols. ThCl ₄ per liter	0.0871	0.0467	0.0251	0.0102	0.0052
Gm. mols. BaSO ₄ per liter	0.0153	0.0103	0.0066	0.0055	0.0025

Results are also shown for the solubility of Barium Sulfate in the presence of varying amounts of Barium Chloride.

Results of Marden, 1916 at 25°

NH₄C₂H₃O₂ 100 gms. sat. solution of BaSO₄ in 21.37% aqueous ammonium acetate solution contain 0.016 gm. at 25°.

SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SALT SOLUTIONS--Cont.

Results of Heyrovsky and Berezicky, 1929 at 18°

LiCl Determinations of the solubility of Barium Sulfate in Water and in aqueous solutions of lithium chloride at 18° made by the "polarographic method." (See Solubility of Barium Carbonate in Water free of CO₂) gave the following results. Note that the value for pure water is considerably higher than those on page 387.

Normality of aq. LiCl solution	Gm. Equiv. of BaSO ₄ dissolved per liter	
0.0	2.10×10^{-5}	SO
0.001	3.10×10^{-5}	
0.010	3.10×10^{-5}	

Results of Benrath and Schackmann, 1934 at 25°:

KMnO₄ Data for the quaternary system BaSO₄ + 2KMnO₄ \rightleftharpoons
 K₂SO₄ Ba(MnO₄)₂ + K₂SO₄ in water are given. The component ternary
 Ba(MnO₄)₂ systems: BaSO₄ - KMnO₄-H₂O, BaSO₄-K₂SO₄-H₂O, and BaSO₄-
 Ba(MnO₄)₂-H₂O were studied but no numerical results are
 given.

SOLUBILITY OF BARIUM SULFATE IN MIXTURES OF WATER
 AND ETHYL ALCOHOL AT 25°
 (Norberg and Clemenson, 1942)

The data were obtained from conductivity measurements. The result in water is higher than those previously reported values.

Solvent	Gram-Equivalents BaSO ₄ per liter	Gms. BaSO ₄ per liter of solvent
Water	3.270×10^{-5}	0.00382
10% Ethyl Alcohol	1.251×10^{-5}	.00146
20% " "	3.821×10^{-6}	.000446
30% " "	1.650×10^{-6}	.000193
40% " "	4.771×10^{-7}	.0000557

Melting point data have been determined for the following:

BaSO₄ + H₂SO₄ (Kendall and Davidson, 1921)
 " + CaCl₂ (Sakur, 1911-12)
 " + KCl (")
 " + NaCl (") (Byé and Holder, 1953)
 " + K₂SO₄ (Grahmann, 1913; Calcagni, 1912)
 " + Li₂SO₄ (Calcagni and Marotta, 1912) (Kordes, Ziegler and
 Proeger, 1954)
 " + Na₂SO₄ (Calcagni, 1912)
 Ba,Na || Cl,SO₄ (Nagornyi and Zimina, 1954)

Ba BARIUM

SO BARIUM Amyl SULFATE $\text{Ba}(\text{C}_5\text{H}_{11}\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$

SOLUBILITY OF MIXED CRYSTALS OF THE ACTIVE AND INACTIVE SALT IN
WATER AT 20.5°
(Marckwald, 1904)

Mixed crystals of the active and inactive barium amyl sulfate were dissolved in water by warming, then cooled to the beginning of crystallization and shaken two hours at 20.5°. The percentage of the active salt was determined by the polarimeter. Its specific rotation was $[\alpha]_D = +2.52^\circ$.

Gms. Salt per 100 Gms. H_2O	Per cent Active Salt in Dissolved Salt	Gms. Salt per 100 Gms. H_2O	Per cent Active Salt in Dissolved Salt
28.2	100	18.3	49.6
26.3	91.6	16.6	36.3
24.8	84.5	15.0	25.8
21.7	72.1	13.6	10.6
19.5	59.5	12.8	0

BARIUM Isoamyl SULFATE $\text{Ba}(\text{C}_5\text{H}_{11}\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$

100 gms. H_2O dissolve 9.71 gms. of the anhydrous salt at 10°, 11.85 gms. at 19.3° and 12.15 gms. at 20.5°. (Marckwald, 1902).

SO BARIUM Persulfate $\text{BaS}_2\text{O}_8 \cdot 4\text{H}_2\text{O}$

100 parts water dissolve 39.1 parts BaS_2O_8 or 52.2 parts $\text{BaS}_2\text{O}_8 \cdot 4\text{H}_2\text{O}$ at 0°. (Marshall, 1891).

SO BARIUM THIOSULFATE BaS_2O_3

SOLUBILITY OF BARIUM THIOSULFATE IN WATER
(Luchinskii and Suzdaleva, 1940)

t°	Gms. BaS_2O_3 per 100 gms. sat. sol.	t°	Gms. BaS_2O_3 per 100 gms. sat. sol.
10	0.194	35	0.309
15	.221	40	.329
18.5	(.210)*	50	.366
20	.243	60	.399
25**	.266		
30	.288		

*Value of Leo, 1922.

**Denny and Monk, 1951 found an average of 0.283 ($\pm 0.2\%$) gms. per 100 cc. sat. sol. at 25°.

SOLUBILITY OF BARIUM THIOSULFATE IN AQUEOUS SALT SOLUTIONS

Results of Leo, 1922 at 18.5°

Solvent	Gms. BaS_2O_3 per 100 gms. sat. sol.
Water	0.2100
250 cc. H_2O + 3.2 gms. $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	0.1375
200 " " + 20.0 " "	0.1480

Results of Denny and Monk, 1951 at 25°

Added Salt	Mmol. per liter sat. sol.		Added Salt	Mmol. per liter sat. sol.		50
	Added Salt	BaS_2O_3		Added Salt	BaS_2O_3	
NaCl	45.76	14.60	MnCl_2	10.64	14.03	
	57.80	15.29		14.98	14.89	
	72.25	15.99		21.02	15.98	
KCl	30.23	14.01	CaCl_2	13.28	14.62	
	44.17	14.81		18.89	15.65	
	56.08	15.42		25.25	16.69	
MgCl_2	13.45	14.49	SrCl_2	8.68	13.72	
	16.30	14.97		12.11	14.48	
	20.54	15.66		17.40	15.53	
CoCl_2	10.36	14.09	ZnCl_2	7.53	13.83	
	15.82	15.21		10.64	14.76	
	22.83	16.47		14.92	15.88	
NiCl_2	10.48	14.12	CdCl_2	4.68	16.92	
	16.77	15.41		7.96	20.90	
	23.59	16.67		11.71	25.42	
BaCl_2	3.67	10.07	$\text{Co}(\text{NH}_3)_6\text{Cl}_3$	1.14	12.25	
	7.41	9.17		1.64	12.64	
	9.67	8.78		4.60	14.85	
				9.61	18.25	

SOLUBILITY OF BARIUM THIOSULFATE IN AQUEOUS ETHANOL SOLUTIONS AT 15°
(Inchinskii and Suzdaleva, 1940)

Wt. % $\text{C}_2\text{H}_5\text{OH}$	Gms. BaS_2O_3 per 100 gms. sat. sol.	Wt. % $\text{C}_2\text{H}_5\text{OH}$	Gms. BaS_2O_3 per 100 gms. sat. sol.
0	0.221	20	0.0323
1	.201	30	.0119
2	.183	40	.0054
5	.134	50	.0038
10	.0807	60	.0034
15	.0504		

SOLUBILITY OF BaS_2O_3 IN AQUEOUS ACETONE AT 18.5°
(Leo, 1922)

0.0318 gms. BaS_2O_3 are contained in 100 gms. of a saturated solution in which the solvent is 50% acetone by volume.

Ba BARIUM

SO BARIUM OITHIOMATE BaS_2O_6 SOLUBILITY IN WATER
(de Baat, 1926; Schreiber, 1933)

t°	Gms. BaS_2O_6 per 100 gms. sat. sol.	Solid Phase
-0.46(Eutec.)	6.0	Ice + $\text{BaS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$
0	6.08	$\text{BaS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$
5	8.40	"
8	9.92	"
12	12.22	"
13	...	" + $\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
15	13.92*	$\text{BaS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$
-0.59(Eutec.)	7.7*	Ice + $\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
0	7.80*	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
5	9.63*	"
12	12.40*	"
15	13.60	"
20	15.70	"
30	19.86	"

*Metastable

THE SYSTEM BaS_2O_6 - $\text{K}_2\text{S}_2\text{O}_6$ - H_2O
(da Baat, 1926)

Results at 0° Gms. per 100 gms. sat. sol.		Results at 20° Gms. per 100 gms. sat. sol.		Results at 30° Gms. per 100 gms. sat. sol.		Solid Phase at Each Temp.
BaS_2O_6	$\text{K}_2\text{S}_2\text{O}_6$	BaS_2O_6	$\text{K}_2\text{S}_2\text{O}_6$	BaS_2O_6	$\text{K}_2\text{S}_2\text{O}_6$	
8.02	1.21	16.43	2.69	20.64	4.16	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
8.88	2.75	17.15	6.03	20.69	8.03	" + $\text{K}_2\text{S}_2\text{O}_6$
4.69	2.60	11.82	6.02	20.50	8.11	$\text{K}_2\text{S}_2\text{O}_6$
0.0	2.52	0.0	6.23	11.74	8.33	"
				6.02	8.49	"
				0.0	8.54	"

THE SYSTEM BaS_2O_6 - $(\text{NH}_4)_2\text{S}_2\text{O}_6$ - H_2O AT 30°
(de Baat, 1926)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
BaS_2O_6	$(\text{NH}_4)_2\text{S}_2\text{O}_6$		BaS_2O_6	$(\text{NH}_4)_2\text{S}_2\text{O}_6$	
0.0	64.60	$(\text{NH}_4)_2\text{S}_2\text{O}_6 \cdot \frac{1}{2}\text{H}_2\text{O}$	6.92	40.15	not stated
0.35	58.64	not stated	8.31	37.90	"
0.62	56.26	"	10.26	37.26	"
1.05	53.81	"	11.21	33.62	"
2.75	48.45	"	17.20	11.0	"
5.28	43.22	"	19.76	0.0	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$

THE SYSTEM $\text{BaS}_2\text{O}_6 - \text{Na}_2\text{S}_2\text{O}_6 - \text{H}_2\text{O}$
(de Baat, 1923, 1926)

Results at 0° Gms. per 100 gms. sat. sol.		Results at 12° Gms. per 100 gms. sat. sol.		Solid Phase at Each Temp.
BaS_2O_6	$\text{Na}_2\text{S}_2\text{O}_6$	BaS_2O_6	$\text{Na}_2\text{S}_2\text{O}_6$	
7.45	2.74	11.05	6.95	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
5.86	6.23	10.76	9.27	" + $\text{Na}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
2.51	6.94	7.57	9.82	$\text{Na}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
0.0	6.05	0.0	10.63	"
Results at 20° Gms. per 100 gms. sat. sol.		Results at 30° Gms. per 100 gms. sat. sol.		Solid Phase at Each Temp.
BaS_2O_6	$\text{Na}_2\text{S}_2\text{O}_6$	BaS_2O_6	$\text{Na}_2\text{S}_2\text{O}_6$	
13.81	6.63	17.06	6.36	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
12.66	11.02	14.45	13.09	" + $\text{Na}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
7.45	12.12	13.23	13.31	$\text{Na}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
0.0	13.39	7.32	14.87	"
		0.0	17.23	"

50

THE SYSTEM $\text{BaS}_2\text{O}_6 - \text{MgS}_2\text{O}_6 - \text{H}_2\text{O}$
(de Baat, 1926)

Results at 20° Gms. per 100 gms. sat. sol.			Results at 30° Gms. per 100 gms. sat. sol.		
BaS_2O_6	MgS_2O_6	Solid Phase	BaS_2O_6	MgS_2O_6	Solid Phase
15.75	0.0	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$	13.37	7.05	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
10.61	6.93	"	5.85	18.91	"
1.29	31.14	"	1.92	29.16	"
0.69	33.95	" + $\text{MgS}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$	0.90	34.57	" + $\text{MgS}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$
0.0	33.91	$\text{MgS}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$	0.0	35.12	$\text{MgS}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$

SOLUBILITY OF BARIUM DITHIONATE IN AQUEOUS SOLUTIONS
OF ETHYL ALCOHOL AT 30°
(de Baat, 1926)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
BaS_2O_6	$\text{C}_2\text{H}_5\text{OH}$		BaS_2O_6	$\text{C}_2\text{H}_5\text{OH}$	
19.86	0.0	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$	0.37	42.53	$\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$
12.74	4.67	"	0.03	61.24	"
4.24	16.86	"	0.01	76.61	"
2.74	21.36	"	0.009	87.00	"
0.86	31.91	"	0.000	98.81	"

Ba BARIUM

SO BARIUM Tetra THIONATE $\text{BaS}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$

SOLUBILITY OF BARIUM TETRATHIONATE IN WATER (Portillo, 1929)

t°	0°	12°.8	27°.5
Gms. BaS_4O_6 per 100 gms. sat. sol.	26.57	29.85	36.0

SOMH BARIUM SULFAMATE $\text{Ba}(\text{SO}_3\text{NH}_2)_2$

SOLUBILITY OF BARIUM SULFAMATE IN WATER (King and Hooper, 1941)

The anhydrous salt is the stable phase throughout the temperature range studied.

Temp.	Gms. $\text{Ba}(\text{SO}_3\text{NH}_2)_2$ per 100 gms. H_2O	Temp.	Gms. $\text{Ba}(\text{SO}_3\text{NH}_2)_2$ per 100 gms. H_2O
0.0°	18.29	50.0°	43.35
10.0°	22.28	60.0°	49.56
20.0°	26.79	70.0°	55.50
*25.0°	29.7	75.0°	58.77
30.0°	32.50	85.0°	64.16
40.0°	38.50	100.2°	73.5

*Interpolated. Cupery (1938) found the solubility to be 34.2 gms. per 100 gms. of water at 25°.

SeO BARIUM SELENITE BaSeO_3

SOLUBILITY IN WATER

t°	Gms. per 100 gms. sat. sol.	
0	0.005	(Neal and McCrosky, 1938)
10	0.01763	(Deliquie, 1943) [after 39 days stirring. Equilib. value probably higher.]
25	0.005	(N. and McCrosky, 1938)
50	0.005	(N. and McCrosky, 1938)

THE SYSTEM BARIUM SELENITE - SELENIUM DIOXIDE - WATER
(Neal and McCrosky, 1938)

Results at 0°			Results at 25°			Results at 50°		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Free SeO ₂	BaSeO ₃	Solid Phase	Free SeO ₂	BaSeO ₃	Solid Phase	Free SeO ₂	BaSeO ₃	Solid Phase
0.0	0.005	N	0.0	0.005	N	0.0	0.005	N
0.17	0.39	"	0.25	0.58	"	0.26	0.67	"
0.27	0.64	" + P	0.42	0.97	" + P	0.52	1.18	" + P
1.11	0.65	P	0.41	0.95	P	1.34	1.16	P
2.04	0.58	"	1.27	0.96	"	4.87	1.28	"
4.57	0.58	"	5.94	0.97	"	13.7	1.45	"
8.80	0.69	"	13.5	1.09	"	24.7	1.80	"
17.9	0.89	"	23.3	1.38	"	37.1	2.38	"
26.6	1.10	"	33.2	1.74	"	44.7	2.81	"
30.6	1.18	"	44.7	2.42	"	57.8	3.90	"
35.6	1.44	"	59.9	3.84	"	68.3	5.32	"
44.3	1.99	"	63.6	4.36	"	71.8	6.42	"
49.7	2.44	"	67.2	5.06	" + A	73.4	6.63	" + A
57.8	3.42	"	67.3	3.61	A	73.8	5.80	A
58.6	3.53	" + A	67.7	3.13	"	74.8	3.66	"
58.7	2.51	A	68.3	1.54	"	75.4	2.75	"
58.8	1.24	"	68.8	0.0	"	76.2	1.51	"
58.9	0.0	"				76.6	0.0	"

N = Barium Selenite, BaSeO₃; P = Barium Pyroselenite, BaSeO₅;
A = Selenious Acid, H₂SeO₃.

BAR IUM SELENATE BaSeO₄

SeO

SOLUBILITY IN WATER

t°	Gms. per liter sat. sol.	
10°	0.0923	(Dolique, 1943)
25°	{ 0.0792 from undersaturation 0.082 from supersaturation	(Meyer and Fredrich, 1922a)

Ba BARIUM

SiO BARIUM SILICATE BaSiO₃

Melting point data are given for:

BaSiO₃ + BaF₂ (Bergman, Nesterova and Bychkova, 1955)
 BaSiO₃ + Li₂SO₃ (") (Wallace, 1909)
 BaSiO₃ + Na₂SO₃ (") (")
 BaSiO₃ + NaF, + Na₄P₂O₇, + Na₂SO₄, + Na₂WO₄, + Na₂MoO₄, + Na₂VO₄ (all ternary systems) (B. N. and B., 1955)
 BaSiO₃ + CaSiO₃ (Lebedev, 1911)
 BaSiO₃ + MnSiO₃ (")
 BaSiO₃ + BaTiO₃ (Smolensky, 1911-12)

TiO BARIUM TITANATE BaTiO₃

SOLUBILITY IN MOLTEN KF (Karan, 1953, 1954)

t°	1000	1050	1100	1150	1200	1250	1300
% BaTiO ₃	4	6	9	12.5	17	22.5	28.5

Melting point data are given for:

BaTiO₃ - K₂CO₃ - Na₂CO₃ } Belyaev and Sholokhovitch, 1951, 1952
 " - BaCO₃ - BaCl₂ }
 " - NaF, - KF, - Na₄P₂O₇, } Sholokhovitch and Belyaev, 1954
 - K₄P₂O₇ }
 " - NaF, - K₄P₂O₇ }
 " - KF }

WO BARIUM TUNGSTATE BaWO₄

From conductivity measurements, Berkem (1943) found the solubility to be 5.0×10^{-5} gm. equiv. per liter (0.0096 gms. per liter of solution) at 25°.

Be BERYLLIUM

BO BERYLLIUM BORATE xBeO·yB₂O₃

Melting points in the system BeO + B₂O₃ + Li₂O were determined by Mazelev, 1940 and Menzel and Sliwinski, 1942.

Br BERYLLIUM BROMIDE BeBr₂

100 cc. pyridine dissolve 18.56 gms. BeBr₂ at 25°. (Muller, B. 1924).

BERYLLIUM MERCURIC BROMIDE, $\text{BeBr}_2 \cdot \text{HgBr}_2$

BR

BASIC BERYLLIUM MERCURIC BROMIDE $3\text{Be}(\text{OH})\text{Br} \cdot 2\text{HgBr}_2$

At 15°, 100 gms. sat. sol. in water contain 80.3 gms. $\text{BeBr}_2 \cdot \text{HgBr}_2$
(solid phase = $\text{BeBr}_2 \cdot \text{HgBr}_2 \cdot 5\text{H}_2\text{O}$).

At 15°, 100 gms. sat. sol. in water contain 88.7 gms. $3\text{Be}(\text{OH})\text{Br}$.
 2HgBr_2 (solid phase = $3\text{Be}(\text{OH})\text{Br} \cdot 2\text{HgBr}_2 \cdot 2\text{H}_2\text{O}$). (Slavvo, 1952).

BERYLLIUM ACETATE (BASIC) $3\text{Be}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{BeO}$

CH

100 gms. chloroform dissolve 33.3 gms. $\text{Be}_4\text{O}(\text{CH}_3\text{COO})_6$ at 18°.
(Wirth, 1914).

BERYLLIUM SALICYLATE $\text{BeC}_7\text{H}_4\text{O}_3$

SOLUBILITY IN WATER
(Jones, Hamer, Davies and Bury, 1930)

t°	moles $\text{BeC}_7\text{H}_4\text{O}_3$ per 1000 gms. H_2O	Gms. $\text{BeC}_7\text{H}_4\text{O}_3$ per 1000 gms. H_2O	Solid Phase
17.92	0.0256	3.72	$\text{BeC}_7\text{H}_4\text{O}_3 \cdot 2\text{H}_2\text{O}$
26.15	0.0311	4.51	"
35	0.038	5.5	"

BERYLLIUM Benzene and Toluene SULFONATES

SOLUBILITY OF EACH IN WATER AT 25°

Compound	Formula	Gms. anhydrous compd. per 100 gms. sat. sol.	Authority
Beryllium benzene sulfonate	$\text{Be}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 4\text{H}_2\text{O}$	53.8	(Sidgwick and Lewis, 1926)
Beryllium p-toluene sulfonate	$\text{Be}(\text{C}_7\text{H}_7\text{SO}_3)_2 \cdot 4\text{H}_2\text{O}$	39.2	"

Be BERYLLIUM

CH BERYLLIUM PALMITATE, STEARATE, LAURATE, MYRISTATE

SOLUBILITIES IN ETHYL AND METHYL ALCOHOLS AT 25° (Jacobson and Holmes, 1916)

Solvent	Gms. of Each Salt (Determined Separately per 100 Gms. Solvent)			
	Be Palmitate	Be Stearate	Be Laurate	Be Myristate
Ethyl Alcohol	0.004	...	0.004	0.004
Methyl Alcohol	0.042	0.040	0.050	0.047

CO BERYLLIUM OXALATE BeC_2O_4

SOLUBILITY IN WATER (Wirth, 1914)

100 gms. H_2O dissolve 63.2 gms. $\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ at 25°.

SOLUBILITY OF BERYLLIUM OXALATE IN AQUEOUS SOLUTIONS IN PRESENCE OF BERYLLIUM OXIDE AT 25° (Sidgwick and Lewis, 1926)

d_{4}^{25} of sat. sol.	Gms. per 100 gms. sat. solution		Solid Phase
	BeC_2O_4	BeO	
1.179	28.20	0.08	$\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
1.224	31.73	1.31	"
1.259	35.01	2.35	"
1.282	37.17	3.23	"
...	41.69	4.02	"
2.290	38.20	3.52	"

EQUILIBRIUM IN THE SYSTEM BERYLLIUM OXALATE, OXALIC ACID AND WATER AT 25° (Sidgwick and Lewis, 1926)

d_{4}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d_{4}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	BeC_2O_4	$\text{H}_2\text{C}_2\text{O}_4$			BeC_2O_4	$\text{H}_2\text{C}_2\text{O}_4$	
1.178	26.55	1.81	Solid solution*	1.168	20.78	7.63	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
				1.139	15.79	8.46	"
1.187	25.33	4.42	"	1.112	11.24	9.07	"
1.188	25.23	4.79	"	1.087	7.60	9.52	"
1.197	24.49	6.88	"	1.064	3.45	10.03	"
1.184	23.90	7.51	"	1.043	0.00	10.23	"
1.197	24.01	7.46	"				

*Solid solutions of $\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ + $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$.

SOLUBILITY OF BERYLLIUM OXALATE IN OTHER ACID SOLUTIONS AT 25°
(Wirth, 1914)

100 gms.	0.1 \bar{n}	oxalic acid	dissolve	75.92 gms.	$\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
"	0.1 \bar{n}	sulfuric	"	72.65	"
"	1.0 \bar{n}	"	"	52.8	"

BERYLLIUM THIOCYANATE $\text{Be}(\text{SCN})_2$

CNS

The extraction of beryllium II from NH_4SCN solutions by ether has been studied by Fischer and Bock, 1943; by butyl acetate by Miller, 1947.

BERYLLIUM CHLORIDE BeCl_2

Cl

SOLUBILITY IN WATER

t°	Gms. BeCl_2 per 100 gms. sat. sol.	Solid Phase	
0	40.35	$\text{BeCl}_2 \cdot 4\text{H}_2\text{O}$	(Novoselova and Sosnovskaya, 1951)
	40.64	"	(Leikina and Nowossekowa, 1937)
20	42.24	"	(" " ")
	42.14	"	(Novoselova, Pashinkin and Semenko, 1955)
25	41.72	"	(Bliden, 1952, 1954)
30	43.52	"	(Leikina and Nowossekowa, 1937)
40	44.12	"	(Bliden, 1952, 1954)

Be BERYLLIUM

SOLUBILITY OF BERYLLIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID (Leikina and Nowossekowa, 1937; Seidel and Fischer, 1941 (*))

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	BeCl ₂	HCl(free)		BeCl ₂	HCl(free)	
Cl	Results at 0°			Results at 20°		
	40.64	0.0	Be ₄	42.24	0.0	Be ₄
	40.44	0.62	"	40.90	0.82	"
	39.45	3.25	SS	39.36	2.79	"
	39.34	3.80	"	36.16	6.27	"
	37.44	3.64	Be ₄	33.47	10.43	" + Be ₂
	35.83	5.58	"	31.36	11.52	Be ₂
	34.56	6.86	"	30.40	12.77	"
	33.60	8.19	"	29.41	13.52	"
	32.10	10.01	"	25.08	17.83	"
	31.2 *	11.6	"	24.00	19.35	"
	30.88	11.63	"	Results at 30°		
	29.60	13.14	" + Be ₂	43.52	0.0	Be ₄
	29.12	13.83	Be ₂	42.79	0.65	"
	26.91	15.41	"	40.00	3.00	"
	23.68	19.69	"	38.10	4.93	"
	22.3 *	20.7	"	37.76	4.84	" + Be ₂
	20.64	22.65	"	36.05	8.44	Be ₂
	13.38	29.90	"	34.20	9.31	"
	10.20	33.31	"	33.60	10.04	"
	9.21	34.85	"	Results at 50°		
				44.17	0.75	Be ₄

Be₄ = BeCl₂·4H₂O; Be₂ = BeCl₂·2H₂O; SS = Solid Solution.

THE SYSTEM BERYLLIUM CHLORIDE - LITHIUM CHLORIDE - WATER (Bliden, 1952, 1954)

Results at 25°			Results at 40°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
LiCl	BeCl ₂		LiCl	BeCl ₂	
45.95	0.0	LiCl·H ₂ O	48.98	0.0	LiCl·H ₂ O
39.46	5.48	"	40.86	6.48	"
37.07	7.92	"	37.67	9.56	"
33.34	11.52	"	30.75	16.12	"
25.27	18.66	"	23.52	22.23	"
18.67	24.46	"	15.53	30.14	"
15.63	27.41	"	7.34	38.02	"
9.14	33.25	"	5.22	39.86	"
6.20	36.07	" + BeCl ₂ ·4H ₂ O	2.14	42.91	" + BeCl ₂ ·4H ₂ O
2.10	39.65	BeCl ₂ ·4H ₂ O	0.0	44.12	BeCl ₂ ·4H ₂ O
0.0	41.72	"			

THE SYSTEM BERYLLIUM CHLORIDE - LITHIUM CHLORIDE - WATER AT 0°
(Novoselova and Sosnovskaya, 1951)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
LiCl	BeCl ₂	Solid Phase	LiCl	BeCl ₂	Solid Phase
41.32	0.0	LiCl·2H ₂ O	15.52 ^m	27.20	LiCl·2H ₂ O + BeCl ₂ ·4H ₂ O
36.57	4.73	"	13.80	28.01	LiCl·H ₂ O
33.58	7.49	"	13.30	29.50	LiCl·H ₂ O + BeCl ₂ ·4H ₂ O
27.56	13.48	"	13.36	29.43	"
25.88	16.22	"	12.30	30.70	BeCl ₂ ·4H ₂ O
23.72	18.23	"	11.12	31.28	"
20.05	22.80	"	5.74	34.50	"
17.20	25.80	"	0.0	40.35	"

Cl

^mMetastable.

THE SYSTEM BERYLLIUM CHLORIDE - AMMONIUM CHLORIDE - WATER AT 20°
(Novoselova, Pashinkin and Semenko, 1955)

Gms. per 100 gms. sat. sol.		Solid Phase
NH ₄ Cl	BeCl ₂	
0.0	42.14	BeCl ₂ ·4H ₂ O
3.25	42.05	BeCl ₂ ·4H ₂ O + NH ₄ Cl
27.36	0.0	NH ₄ Cl

The extraction of BeCl₂ from NH₄SCN solutions by ether has been studied by Fischer and Bock, 1943; by butyl acetate by Miller, 1947.

0.335 gms. BeCl₂ dissolve in 100 cc. of a mixture of equal volumes of ether and water which is saturated with HCl at 0°. (Fischer and Seidel, 1941).

SOLUBILITY IN SEVERAL ORGANIC SOLVENTS AT 20°
(Schmidt, 1929)

Solvent	Formula	Gms. BeCl ₂ per liter sat. sol.
Methyl alcohol	CH ₃ OH	256.7
Ethyl alcohol	C ₂ H ₅ OH	151.1
Amyl alcohol	C ₅ H ₁₁ OH	153.6
Pyridine	CH ₃ (CH ₂) ₄ N	133.3

Be BERYLLIUM

SOLUBILITY OF BeCl_2 IN LIQUID SULFUR DIOXIDE

100 gms. liquid SO_2 dissolve 0.046 gm. BeCl_2 at 0° . (Jander and Ruppold, 1937).

Melting point data are given for:

$\text{BeCl}_2 + \text{CaCl}_2, + \text{CdCl}_2, + \text{LiCl}, + \text{MgCl}_2, + \text{NaCl}, + \text{PbCl}_2, + \text{TlCl}, + \text{ZnCl}_2$
(Schmidt, 1926, 1929)

$\text{BeCl}_2 + \text{CeCl}_3 + \text{NaCl}$
(Nishihara, Shimizu, and Morita, 1951)

$\text{BeCl}_2 + \text{Capronitrile}, + \text{Propionitrile}, + \text{Tolunitrile}$
(Frick and Rode, 1927)

Cl BERYLLIUM MERCURIC CHLORIDE $\text{BeCl}_2 \cdot \text{HgCl}_2$

BASIC BERYLLIUM MERCURIC CHLORIDE $\text{Be(OH)Cl} \cdot \text{HgCl}_2$

At 15° a saturated solution in water contains 95% $\text{BeCl}_2 \cdot \text{HgCl}_2 \cdot 5\text{H}_2\text{O}$.

At 15° 100 gms. of a saturated solution in water contain 90.0 gms. $\text{Be(OH)Cl} \cdot \text{HgCl}_2 \cdot 2\text{H}_2\text{O}$. (Slavvo, 1952a).

ClO BERYLLIUM PERCHLORATE BeClO_4

100 gms. sat. sol. of beryllium perchlorate in water contain 59.5 gms. $\text{Be(ClO}_4)_2$ at 25° . (Solid phase = $\text{Be(ClO}_4)_2 \cdot 4\text{H}_2\text{O}$). (Sidgwick and Lewis, 1926).

F BERYLLIUM FLUORIDE BeF_2

SOLUBILITY IN WATER AT 25°

(Linnell and Haendler, 1948; Novoselova, Tamm and Vorobeve, 1955)

Beryllium fluoride is extremely soluble but dissolves very slowly in water, and did not reach the saturation value within two to three months of constant agitation. For example, Novoselova, Tamm and Vorobeve found:

Days stirred	Moles BeF_2 per liter
21	9.72
38	13.74
66	16.73
82	17.08

Extrapolation of these, and the data of Linnell and Haendler indicate a probable equilibrium value of about 18 molar (846g./liter of solution; density = 1.55). At saturation, the ratio $\text{BeF}_2 : \text{H}_2\text{O}$ is about 2.2. The gain in weight of BeF_2 when exposed to various vapor pressures of water was also determined, and limiting ratios of $\text{BeF}_2 : \text{H}_2\text{O}$ in the solid of 1:2, 1:2.5, and 1:5 were found. From conductance and freezing point data it is estimated that a 1 molar solution of the salt is only 2% ionized. (L. and H.).

FREEZING POINTS OF DILUTE BeF_2 SOLUTIONS
(Tananaev and Deichman, 1951)

Moles BeF_2 per liter	0.4	1.0	1.4	2.0
Freezing pt. $^{\circ}\text{C}$	-1.6	-4.2	-6.9	-10.3

FREEZING POINTS OF DILUTE SOLUTIONS CONTAINING $\text{BeF}_2 + \text{Be}(\text{NO}_3)_2$
(Tananaev and Deichman, 1951)

$$[M_{\text{BeF}_2} + M_{\text{Be}(\text{NO}_3)_2} = 2.0]$$

Moles per liter		Freezing Point	Moles per liter		Freezing Point
BeF_2	$\text{Be}(\text{NO}_3)_2$		BeF_2	$\text{Be}(\text{NO}_3)_2$	
0.33	1.67	-4.5	1.09	0.91	-7.4
0.75	1.25	-6.0	1.23	0.77	-7.8
1.00	1.00	-7.2	1.33	0.67	-8.1

THE SYSTEM BERYLLIUM FLUORIDE - AMMONIUM FLUORIDE - WATER
(Novoselova, 1939 at 0° ; Novoselova and Averkova, 1939 at 25°)

Results at 0°

Gms. per 100 gms. sat. sol.		Solid Phase
NH_4F	BeF_2	
15.45	33.70	$\text{BeF}_2 \cdot \text{NH}_4\text{F}$
15.60	30.40	"
16.50	28.50	"
18.76	26.90	"
19.90	25.10	"
21.80	24.70	"
21.74	25.00	"
21.80	25.10	" + SS
21.57	22.48	SS
20.37	22.05	"
20.15	20.16	"
18.97	17.75	"
17.50	18.21	"
16.20	10.60	" + $\text{BeF}_2 \cdot 2\text{NH}_4\text{F}$
17.40	8.76	$\text{BeF}_2 \cdot 2\text{NH}_4\text{F}$
19.08	7.00	"
20.60	6.30	"
25.85	5.06	"
37.30	4.14	"
43.40	2.49	" + NH_4F
43.20	0.50	NH_4F
43.40	0.0	"

Results at 25°

Gms. per 100 gms. sat. sol.		Solid Phase
NH_4F	BeF_2	
43.40	0.0	NH_4F
43.20	0.50	"
43.40	2.49	" + $2\text{NH}_4\text{F} \cdot \text{BeF}_2$
37.30	4.14	$2\text{NH}_4\text{F} \cdot \text{BeF}_2$
25.85	5.06	"
20.60	6.30	"
19.08	7.00	"
17.40	8.76	"
16.20	10.60	" + Solid Sol'n.
17.50	13.21	Solid Solution
18.07	15.42	"
18.97	17.75	"
20.15	20.16	"
20.37	22.05	"
21.57	22.48	"
21.80	25.10	" + $\text{NH}_4\text{F} \cdot \text{BeF}_2$
21.74	25.00	$\text{NH}_4\text{F} \cdot \text{BeF}_2$
21.80	24.70	"
19.30	25.10	"
18.76	26.90	"
16.50	28.50	"
15.60	30.40	"
15.45	33.70	"

Be BERYLLIUM

THE SYSTEM BERYLLIUM FLUORIDE - POTASSIUM FLUORIDE - WATER AT 25° (Novoselova, Tamm and Vorobeve, 1955)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	KF	BeF ₂		KF	BeF ₂	
	48.99	0.0	KF.2H ₂ O	6.37	16.90	K ₂ BeF ₄
	46.68	0.0066	" + K ₂ BeF ₄	6.03	17.43	" + KBeF ₃
	32.70	0.0050	K ₂ BeF ₄	6.17	24.41	KBeF ₃
	11.71	0.0076	"	5.95	28.07	"
	5.83	0.027	"	6.16	33.53	" + KBe ₂ F ₅
F	1.08	0.44	"	3.50	46.67	KBe ₂ F ₅
	2.53	3.14	"	2.70	53.14	"
	5.20	12.27	"			

Marignac; Sestini, 1890 found the solubility of BeF₂.KF in water to be 2.0 gms. per 100 gms. H₂O at 20°, and 5.2 gms. at 100°.

THE SYSTEM BERYLLIUM FLUORIDE - SODIUM FLUORIDE - WATER

Marignac; Sestini, 1890 found the solubility of BeF₂.NaF in water to be 1.4 gms. per 100 gms. H₂O at 20°, and 2.8 gms. at 100°.

SOLUBILITY OF BERYLLIUM DOUBLE FLUORIDES IN WATER (Perfect, 1952; Novoselova, 1934; Marignac, 1866; Sestini, 1890)

Perfect obtained self-consistent data by analyzing for beryllium colorimetrically, but could not reproduce the data by titrating fluoride with thorium nitrate. The beryllium analysis yielded data which is in approximate agreement with the older work. Temperatures are ± 1° and mixtures were stirred for 24 hours.

Data of Perfect in gms. anhydrous salt per liter of saturated solution.

t°	BeF ₂ .2NaF	BeF ₂ .2KF	BeF ₂ .2LiF	BeF ₂ .2NH ₄ F	BeF ₂ .BaF ₂	BeF ₂ .CaF ₂
20	14.93	17.63	12.46	341.0	...	2.66
30	17.03	19.75	14.44	388.0	6.89	2.89
40	17.56	23.50	57.76*	402.8	7.92	..
50	19.57	26.28	55.38	435.5	8.87	3.17
60	20.30	31.99	53.50	462.0	9.85	..
70	23.51	34.60	51.53	490.0	11.83	4.45
80	24.93	39.33	46.78	511.0	11.83	5.10
90	26.43	44.5	45.30	540.4	...	5.15
100	27.01	50.34	42.03	555.8	14.79	5.60

*phase change

(Cont.)

SOLUBILITY OF BERYLLIUM DOUBLE FLUORIDES IN WATER--Cont.

Data of Novoselova, 1934; Marignac, 1886; Sestini, 1890:
(Gms. per 1000 gms. saturated solution)

t°	BeF ₂ ·2NaF		BeF ₂ ·2KF (M., S.)
	(N.)	(M., S.)	
0	13.1	..	..
20	..	14	20
40	18.8	..	..
80	25.5	..	..
94	27.0	..	..
100	..	28	52

F

SOLUBILITY OF BeF₂ IN ETHYL ALCOHOL
(Linnell and Haendler, 1948)

At 25°, the solubility in 100% Ethyl Alcohol is about 1 gm. per liter.

SOLUBILITY OF BeF₂ IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

(Solid phase unsolvated)

t°	-24.2	-5.1	11.2
Gms. BeF ₂ per 100 gms. HF	0.014	0.013	0.015

Melting point data are given for:

- BeF₂ + NaF (Roy, Roy and Osborn, 1950) (Thilo and Schroder, 1951)
(Novoselova, Levina, Simanov, and Zhasmin, 1944)
BeF₂ + LiF (Roy, Roy and Osborn, 1950) (Novoselova, Simanov and
Yarembash, 1952) (Thilo and Lehmann, 1949)
BeF₂ + RbF (Roy, Roy and Osborn, 1950)
BeF₂ + CaF₂ (Counts, Roy and Osborn, 1953)
BeF₂ + MgF₂ (")

BASIC BERYLLIUM MERCURIC IODIDE 3Be(OH)I·2HgI₂

When concentrated at 16° over H₂SO₄, crystals of 3Be(OH)I·2HgI₂·6H₂O formed. The mother liquor contained 91 gms. 2Be(OH)I·2HgI₂ per 100 gms. solution.

The solubility in CCl₄ is 0.03%.

" " " CHCl₃, C₆H₆, C₆H₅CH₃ is 0.15-0.18%.

(Slavvo, 1952)

Be BERYLLIUM

NO BERYLLIUM NITRATE $\text{Be}(\text{NO}_3)_2$

SOLUBILITY OF BERYLLIUM NITRATE IN WATER
(Sieverts and Petzold, 1933; Nowasselow and Nogorokaya, 1935 (*))

t°	Gms. $\text{Be}(\text{NO}_3)_2$ per 100 gms. sat. sol.	Solid phase	t°	Gms. $\text{Be}(\text{NO}_3)_2$ per 100 gms. sat. sol.	Solid Phase
-6.3	13.0	Ice	-40.0	46.2	$\text{Be}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
-15.3	20.9	"	0	49.66*	"
-23.0	24.8	"	+0.4	49.4	"
-27.3	27.5	"	15.0	51.2	"
-29.7	28.3	"	20	51.69*	"
-34.4	30.9	"	30.0	52.3	"
-46.0	34.0	"	50.0	58.6	"
-59.0	37.7	"	61.0	64.8	"

The curves plotted from the above results indicate that the eutectic temperature is lower than -90°

Freezing points of dilute $\text{Be}(\text{NO}_3)_2$ solutions given in molarity:
(Tananaev and Deichman, 1951).

Moles $\text{Be}(\text{NO}_3)_2$ per liter	0.4	0.8	1.4	2.0
Freezing point °t	-0.2	-1.00	-2.00	-3.0

SOLUBILITY OF BERYLLIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID
(Nowasselow and Nogorokaya, 1935)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HNO ₃	Be(NO ₃) ₂		HNO ₃	Be(NO ₃) ₂	
Results at 0° (stable)			Results at 0° (unstable)		
0.0	49.66	Be(NO ₃) ₂ ·4H ₂ O	59.49	26.40	Be(NO ₃) ₂ ·3H ₂ O
30.40	28.87	"	56.84	31.71	"
43.26	20.31	"	55.21	34.21	" + Be(NO ₃) ₂ ·2H ₂ O
55.77	14.04	"	57.92	32.06	Be(NO ₃) ₂ ·2H ₂ O
64.84	10.26	"	62.13	28.50	" + Be(NO ₃) ₂ ·H ₂ O
69.42	8.34	"	62.25	28.60	Be(NO ₃) ₂ ·H ₂ O
68.86	10.10	"	61.70	29.30	"
62.51	22.33	" + Be(NO ₃) ₂ ·3H ₂ O	Results at 20°		
65.11	21.16	Be(NO ₃) ₂ ·3H ₂ O	0.0	51.69	Be(NO ₃) ₂ ·4H ₂ O
65.05	22.28	"	22.63	37.97	"
65.52	21.96	"	38.28	28.93	"
64.72	24.04	"	38.11	29.24	"
63.83	26.16	"	45.68	25.66	"
53.19	27.65	" + Be(NO ₃) ₂ ·2H ₂ O	55.12	23.24	"
57.36	31.16	Be(NO ₃) ₂ ·2H ₂ O	52.90	25.95	"
65.31	26.42	"	50.91	29.40	" + Be(NO ₃) ₂ ·3H ₂ O
69.78	22.49	"	50.84	29.51	Be(NO ₃) ₂ ·3H ₂ O
74.97	18.88	" + Be(NO ₃) ₂ ·H ₂ O	51.20	32.01	"

SOLUBILITY OF BERYLLIUM NITRATE IN ETHER

10 ml. of a saturated solution of beryllium nitrate in ether contains 0.2 gm. BeO. (Wells, 1930).

100 cc. of a saturated solution of $\text{Be}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ in ethyl ether, prepared by frequent agitation and allowing to stand at least 20 hours, contain 0.027 gm. BeO. A saturated ethereal solution prepared as above but with beryllium nitrate previously dehydrated at 150° contains only 0.002 gm. BeO per 100 cc. (Wells, 1930).

BERYLLIUM OXIDE

O

BERYLLIUM HYDROXIDE

OH

SOLUBILITY IN WATER

Remy and Kuhlmann (1924) and Remy (1925) found one liter of water dissolves 0.00005 to 0.00020 gm. BeO at about 20° , as determined by the conductivity of the saturated solution, assuming complete dissociation of $\text{Be}(\text{OH})_2$. Oka (1940) found 1.4×10^{-7} mole (0.0000035 gm. BeO per liter by potentiometric titration).

SOLUBILITY IN CARBONIC ACID SOLUTION AT 20°

100 gms. of water "saturated" with CO_2 at 20° contain 0.0185 gm. BeO. (Marignac; Sestini, 1890).

SOLUBILITY OF BERYLLIUM HYDROXIDE IN AQUEOUS
SOLUTIONS OF SODIUM HYDROXIDE
(Rubenbauer, 1902)

Per 20 cc. Solution		Molecular Dilution of the NaOH	Gms. per 100 cc. Solution	
Gms. Na	Gms. Be		NaOH	$\text{Be}(\text{OH})_2$
0.3358	0.0358	1.37	2.917	0.850
0.6716	0.0882	0.68	5.840	2.094
0.8725	0.1175	0.53	7.585	2.789
1.7346	0.2847	0.27	18.310	6.760

SOLUBILITY IN AQUEOUS SODIUM HYDROXIDE AT DIFFERENT TEMPERATURES
(Haber and Oordt, 1904)

Normality of Aq. NaOH	Gm. BeO per Liter Sat. Sol. at:		
	$20-23^\circ$	$50-53^\circ$	100°
0.5	0.060	0.080	0.080
1	0.170	0.230	0.290
2	0.570	0.900	1.020

Be BERYLLIUM

EQUILIBRIUM IN THE SYSTEM BERYLLIUM HYDROXIDE, SODIUM HYDROXIDE AND WATER AT 30° (Fricke and Huame, 1929)

Beryllium hydroxide was precipitated from beryllium sulfate solution by addition of ammonia. This precipitate was washed and digested on a sand bath under reflux condenser with aqueous 10% ammonia. It was a fine white powder corresponding in composition to $\text{BeO} \cdot \text{H}_2\text{O}$. Its solubility in aqueous sodium hydroxide solutions was independent of the relative excess of solid used. The time allowed for equilibrium varied from 3 to 14 days. Using x-rays, two easily distinguishable modifications were found.

OH	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	NaOH	BeO		NaOH	BeO	
	14.10	0.159	Double pyramids	36.32	3.22	Fine needles
	16.20	0.197	" of $\text{BeO} \cdot \text{H}_2\text{O}$	39.00	3.04	" of $\text{BeO} \cdot \text{NaOH} \cdot \text{H}_2\text{O}$
	19.52	0.352	"	40.04	3.06	"
	24.16	0.780	"	43.38	3.35	"
	28.27	1.66	"	43.89	3.40	"
	31.00	2.95	"	46.47	3.78	"
	34.10	4.66	"			

THE SYSTEM BERYLLIUM HYDROXIDE - HYDROGEN PEROXIDE - WATER AT 0° (Volnov, 1955)

Gms. H_2O_2 per 100 gms. Sat. Sol.	Gms. per 100 gms. original mixture		Solid Phase
	H_2O_2	BeO	
8.42	8.26	6.3	$\text{Be}(\text{OH})_2$
44.2	41.7	5.0	"
68.6	63.3	5.7	"
85.6	79.3	5.9	"

PO BERYLLIUM PHOSPHATE $\text{Be}_3(\text{PO}_4)_2$

SOLUBILITY IN ACETIC ACID SOLUTIONS AT 20° (Marignac; Sestini, 1890)

0.055 gms. $\text{Be}_3(\text{PO}_4)_2$ dissolve in 100 gms. of 2% acetic acid
 0.1725 " " " " " " " " 10% " "
 (Solid phase = $\text{Be}_3(\text{PO}_4)_2 \cdot 6\text{H}_2\text{O}$)

PO BERYLLIUM Ammonium PHOSPHATE $\text{Be}(\text{NH}_4)\text{PO}_4$

One liter water dissolves 0.012 gm. $\text{Be}(\text{NH}_4)\text{PO}_4$ at room temperature. The solid phase is probably $\text{BeNH}_4\text{PO}_4 \cdot \text{H}_2\text{O}$. (Cupr, 1929).

SOLUBILITY IN WATER

All investigators agree on the presence of 4- and 2- hydrates. Rohmer (1943) claims to have found a 5- and 1- hydrate in addition and believes the 2- hydrate to be wholly metastable. The tie-line data at -17.5° upon which the identity of the 5-hydrate is based are not conclusive. Campbell, Sukava and Koop (1951) using dilatometric, x-ray and vapor pressure measurements as well as solubilities found no evidence of the 1- hydrate. Both authors agree that the transition temperature $\text{BeSO}_4 \cdot 4\text{H}_2\text{O} \rightarrow \text{BeSO}_4 \cdot 2\text{H}_2\text{O} + \text{aq.}$ is 89° . Rohmer's data are generally lower than those of other workers. The earlier reports of a 6- hydrate by Wirth (1913) and Levi-Malvano (1906) have not been confirmed.

Results below 0° :

Gms. BeSO_4 per 100 gms. sat. sol.				Gms. BeSO_4 per 100 gms. sat. sol.			
Schreiner and Sieverts				Schreiner and Sieverts			
t°	Rohmer 1943	1935	Solid Phase	t°	Rohmer 1943	1935	Solid Phase
-2	7.4	10.0	Ice	-15	22.7	..	Ice
-4	..	15.0	"	-16	...	26.0	"
-6	..	17.0	"	-18	...	27.0	" + $.4\text{H}_2\text{O}$
-7	16.9	..	"	-21.5	24.8 ^m	..	" + $.4\text{H}_2\text{O}$
-8	..	19.5	"	-18.5	24.0	..	" + $.5\text{H}_2\text{O}(?)$
-10	19.8	21.5	"	-17.5	24.8	..	$\text{BeSO}_4 \cdot 5\text{H}_2\text{O}(?)$
-12	..	23.0	"	-16.4	25.0	..	$.5(?) + .4\text{H}_2\text{O}$
-14	..	24.7	"	-10	25.2	..	$\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$
				-5	25.7	..	"

^mMetastable

(Cont.)

Be BERYLLIUM

SOLUBILITY OF BeSO_4 IN WATER--Cont.

Results above 0°:						
Gms. BeSO ₄ per 100 gms. sat. sol.						
t°	Rohmer 1943	Schreiner and Sieverts 1935	Levi-	Others	Density Sat. Sol. (Schroder)	
			Molvano 1906 Shroder 1936			
Solid Phase BeSO ₄ ·4H ₂ O						
50	0	26.1	27.0	27.0	26.63b, 26.72d	1.268
	5	26.5	..	..	....	...
	10	27.0	..	..	....	...
	15	27.5	27.5	28.4	....	1.287
	20	28.0	..	..	....	...
	25	28.5	28.7	29.6	29.32a, 29.13b, 29.94c, 29.29d, 29.74e, 28.72g	1.301
	30	29.1	..	..	29.99b	...
	35	29.8	..	..	....	...
	40	30.7	31.4	32.0	....	1.320
	45	31.6	..	..	....	...
	50	32.6	..	..	32.93a, 33.22b, 33.31d	...
	55	33.9	..	..	....	...
	60	35.1	34.7	35.7	35.05b	1.350
	65	36.3	..	..	....	...
	70	37.5	..	..	....	...
	75	38.7	..	..	37.98a, 38.62b, 38.96d	...
	80	40.0 ^m	40.2	41.0	39.82f	1.401
	85	41.6 ^m	..	..	41.33a, 42.14d(86°)	...
	90	43.0 ^m	..	..	....	...
	95	44.5 ^m	..	..	43.45a	...
	100	46.1 ^m	45.3	46.5	....	1.448
	105	47.9 ^m	..	..	....	...
	110	49.4 ^m	47.0(?)	..	....	...
	115	51.0 ^m	..	..	....	...
	117	51.6 ^m	..	..	....	...

^m = Metastable.

a = Campbell, Sukova and Koop, 1951

b = Schroder, 1938; Schroder and Schwedt, 1938; Schroder, Beckmann, and Ansel, 1939

c = Britton, 1921, 1922a

d = Schroder, Hompesch and Mirbach, 1938

e = Sidgwick and Lewis, 1926

f = Novossjolova, Bodaljova and Guenstein, 1938

g = Novoselova, Vorobeve, Knyazeva and Paskutskaya, 1953; Vorobeve and Osanova, 1953

(Cont.)

SOLUBILITY OF BeSO_4 IN WATER--Cont.Results above 0° --Cont.:Gms. BeSO_4 per 100 gms. sat. sol.

t°	Levi-Molvano				Density Sat. Sol. (Schroder)
	Rohmer 1943	Schreiner and Sieverts 1935	1906 Shroder 1936	Others	
Solid Phase $\text{BeSO}_4 \cdot 2\text{H}_2\text{O}$. ($\text{BeSO}_4 \cdot 4\text{H}_2\text{O} + \text{BeSO}_4 \cdot 2\text{H}_2\text{O}$)					
88.4*	42.6 ^m	...	...	....	...
90.5	...	...	...	43.70d	...
95	42.8 ^m	...	...	43.45a	...
99	...	...	43.8	....*	1.422
99.5	...	...	...	43.70, 43.51b	...
100	43.2 ^m	...	...	....	...
105	43.1 ^m	...	...	....	...
108.2	boiling pt. (a)	...	...	....	...
110	43.2 ^m	...	...	....	...
Solid Phase $\text{BeSO}_4 \cdot \text{H}_2\text{O}$ (Rohmer, 1943)					

t°			t°	
76	39.0	($\text{BeSO}_4 \cdot 4\text{H}_2\text{O} + \text{BeSO}_4 \cdot \text{H}_2\text{O}$)	95	31.9
80	37.5		100	30.0
85	35.7		105	28.1
90	33.8		109.4	26.

^m = metastable* = Campbell, Sukova and Koop, 1951 found the transition $\cdot 4\text{H}_2\text{O} \rightarrow \cdot 2\text{H}_2\text{O}$ to occur at 89.0°

a = Campbell, Sukova and Koop, 1951

b = Schroder, 1938; Schroder and Schwedt, 1938; Schroder, Beckmann, and Ansel, 1939

d = Schroder, Hompesch and Mirbach, 1938

SOLUBILITY OF BERYLLIUM SULFATE IN SOLUTIONS OF BERYLLIUM OXIDE

(Josian, 1940 at 13.5° ; Sidgwick and Lewis, 1926 at 25°)Solid Phase $\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$ Results at 13.5° Results at 25°

Gms. per 100 ml. sat. sol.		Gms. per 100 gms. sat. sol.		Density ²²
BeSO_4	BeO	BeSO_4	BeO	
35.0	0.0	29.74	0.0	1.278
35.4	0.65	31.73	2.16	1.318
36.9	1.67	32.12	2.62	1.327
37.8	2.20	33.86	4.03	...
38.9	2.92	34.55	4.26	1.347
39.5	2.90	34.87	5.02	...
40.1	3.48	36.46	6.10	...
43.0	4.56	37.48	7.73	1.416
49.2	7.26			

Be BERYLLIUM

THE SOLUBILITY OF BERYLLIUM SULFATE IN SULFURIC ACID SOLUTIONS
(Campbell, Sukava and Koop, 1951; Rohmer, 1943 (-17.5, 100°)
Britton, 1921 (25°))

Data for this system at 0°, 25°, 50° and 75° are given by L. Schreiner, Dissertation Jena, 1932, and the curves only are given by Schreiner and Sieverts, 1935, who state that their 25° isotherm agrees well with the previous determinations of Britton, 1921.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
BeSO ₄	H ₂ SO ₄	Solid Phase	BeSO ₄	H ₂ SO ₄	Solid Phase	BeSO ₄	H ₂ SO ₄	Solid Phase
<u>Results at 17.5°(?)</u>			<u>Results at 50°</u>			<u>Results at 95°</u>		
24.8	0.0	Be ₃ (?)	32.93	0.0	Be ₄	43.45	0.0	Be ₂
22.2	3.5	"	21.02	16.01	"	41.80	1.20	"
20.2	6.0	"	13.38	29.83	"	34.41	7.34	"
19.0	7.5	"	9.45	39.67	"	26.86	17.50	"
18.0	8.9	Be ₅ + Be ₄	8.64	42.77	" + Be ₂	25.34	19.98	"
17.1	10.8	Be ₄	8.91	42.75	" + "	23.10	22.85	"
			8.03	43.34	Be ₂	16.04	33.89	"
			4.89	49.98	"	9.16	46.40	"
<u>Results at 13.5°</u> (given in gms. per 100 ml. sat. sol.)			2.37	58.54	"	6.36	53.50	"
			1.54	64.49	"	4.65	61.24	"
			1.61	71.12	"	4.89	68.36	"
			2.71	78.03	"	6.04	70.95	"
<u>Results at 25°</u>			<u>Results at 75°</u>			<u>Results at 100°</u>		
35.0	0.0	Be ₄	37.98	0.0	Be ₄	30.0	0.0	Be ₁
34.2	0.78	"	35.77	2.14	"	19.1	13.3	"
32.1	3.83	"	26.45	16.14	"	11.2	27.5	"
28.9	8.13	"	23.68	21.01	"	4.1	50.8	"
26.8	11.0	"	23.52	21.90	" + Be ₂	0.6	76.2	"
24.1	14.6	"	23.12	22.00	" + "	0.0	90.0	"
20.3	16.1	"	23.64	21.68	" + "	0.0	95.0	Be ₀
9.88	40.3	"	19.76	26.55	Be ₂	*43.5	0.0	Be ₂
6.65	50.4	"	14.61	34.02	"	*25.8	19.7	"
<u>Results at 25°</u>			7.18	48.04	"	*22.2	24.4	"
29.32	0.0	Be ₄	4.14	56.03	"	*12.8	37.8	"
20.51	12.91(B)	"	2.42	66.30	"	* 4.4	64.5	"
15.91	19.17(B)	"	3.40	69.29	"	*46.0	0.0	Be ₄
13.65	22.36(B)	"	4.28	75.29	"	*44.2	9.0	"
12.64	23.88	"						
8.66	32.04(B)	"						
5.25	40.34(B)	"						
4.39	43.23	"						
3.54	46.59(B)	"						
3.10	51.42	"						
3.06	54.29	Be ₄ + Be ₂	<u>Results at 85°</u>			* Metastable		
2.04	55.50(B)	Be ₂	41.33	0.0	Be ₄	Be ₅	= BeSO ₄ ·5H ₂ O	
1.43	60.15	"	36.42	4.14	"	Be ₄	= BeSO ₄ ·4H ₂ O	
0.98	62.02(B)	"	33.82	9.54	" + Be ₂	Be ₂	= BeSO ₄ ·2H ₂ O	
1.28	62.08	"	33.63	9.00	" "	Be ₁	= BeSO ₄ ·H ₂ O	
0.86	66.10(B)	"	21.31	12.05	Be ₂	Be ₀	= BeSO ₄	
0.87	66.0(B)	"						
0.90	66.65	"						
0.64	74.65	"						
1.55	80.60	"						

THE SYSTEM BERYLLIUM SULFATE - AMMONIUM SULFATE - WATER
(Britton, 1922a; Schröder and Schwedt, 1938;
Schröder, Beckmann and Ansel, 1930)

Results at 85°, and the densities of the saturated solutions are also given.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
(NH ₄) ₂ SO ₄	BeSO ₄		(NH ₄) ₂ SO ₄	BeSO ₄	
<u>Results at 0°</u>					
0.0	26.63	Be ₄	26.97	23.53	Be ₄ + NH ₄
1.81	26.50	"	27.63	22.11	NH ₄
6.64	25.99	"	31.97	13.96	"
11.34	25.34	"	37.60	5.09	"
18.78	24.34	"	41.39	0.0	"

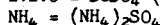
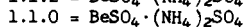
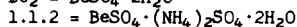
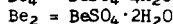
50

Results at 25°

(Schröder)			(Britton)		
0.0	29.13	Be ₄	0.0	29.94	Be ₄
6.53	28.89	"	5.77	28.56	"
18.00	28.42	"	15.66	27.26	"
23.35	28.43	" + 1.1.2	24.99	26.68	"
26.21	25.54	1.1.2	28.09	26.79	" + 1.1.2
28.18	23.63	"	32.20	24.04	1.1.2
21.93	22.27	" + NH ₄	34.26	22.08	"
35.51	18.74	NH ₄	37.56	19.72	" + NH ₄
39.64	5.92	"	35.88	16.04	NH ₄
43.42	0.0	"	38.60	8.62	"
			43.45	0.0	"

Results at 50°

0.0	33.22	Be ₄	31.10	23.03	1.1.2
12.72	34.51	"	36.94	20.91	" + NH ₄
17.74	35.01	"	40.03	13.77	NH ₄
19.83	35.38	" + 1.1.2	43.33	5.48	"
25.50	20.03	1.1.2	45.72	0.0	"



(Cont.)

Be BERYLLIUM

THE SYSTEM BERYLLIUM SULFATE - AMMONIUM SULFATE - WATER--Cont.

Gms. per 100 gms. set. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
(NH ₄) ₂ SO ₄	BeSO ₄		(NH ₄) ₂ SO ₄	BeSO ₄	

<u>Results at 60°</u>						
50	0.0	35.05	Be ₄	28.96	24.34	1.1.2
	3.38	35.41	"	34.50	20.98	"
	14.61	36.92	"	38.48	19.86	" + NH ₄
	17.78	37.12	" + 1.1.2	41.70	11.43	NH ₄
	20.09	32.95	1.1.2	46.69	0.0	"
	24.93	27.31	"			

<u>Results at 75°</u>						
50	0.0	38.62	Be ₄	29.25	23.92	1.1.2
	5.61	39.78	"	36.54	20.01	"
	10.58	40.45	"	41.88	17.77	" + NH ₄
	14.20	40.88	" + 1.1.2	44.78	9.96	NH ₄
	20.90	31.29	1.1.2	48.30	0.0	"
	23.23	28.57	"			

<u>Results at 99.5°</u>						
50	0.0	43.70	Be ₂	35.91	19.61	1.1.0
	10.77	42.34	"	41.14	16.69	"
	13.17	41.80	" + 1.1.0	46.69	13.80	" + NH ₄
	18.93	33.78	1.1.0	48.79	6.21	NH ₄
	25.98	26.21	"	50.79	0.0	"
	31.01	22.68	"			

Be ₄ = BeSO ₄ · 4H ₂ O
Be ₂ = BeSO ₄ · 2H ₂ O
1.1.2 = BeSO ₄ · (NH ₄) ₂ SO ₄ · 2H ₂ O
1.1.0 = BeSO ₄ · (NH ₄) ₂ SO ₄
NH ₄ = (NH ₄) ₂ SO ₄

THE SYSTEM BERYLLIUM SULFATE - POTASSIUM SULFATE - WATER
(Schröder, 1938; Britton and Allmand, 1921 at 25°)

Britton and Allmand's data have been recalculated. Results for the densities of the saturated solutions are also given. Freezing-point data for mixtures of beryllium sulfate and potassium sulfate are given by Grahmann (1913).

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
K ₂ SO ₄	BeSO ₄		K ₂ SO ₄	BeSO ₄	
<u>Results at 0°</u>					
0.0	26.63	Be ₄	7.78	13.68*	1.1.2 + K
1.05	26.13	"	7.83	8.55*	K
1.52	25.81	" + 1.1.2	7.79	7.60*	"
1.60	25.77	1.1.2	7.72	6.59	" + 1.1.2
2.29	21.90	"	7.62	6.20	K
3.22	17.99	"	7.32	3.53	"
4.74	12.08	"	7.16	1.37	"
6.75	8.11	"			

SO

Results at 25°

(Schröder)

(Britton and Allmand)

0.0	29.13	Be ₄	1.87	28.33	Be ₄
1.58	28.44	"	3.06	28.19	"
1.92	28.10	" + 1.1.2	4.78	26.67	" + 1.1.2
2.82	22.94	1.1.2	4.64	24.01	1.1.2
3.34	20.51	"	6.14	13.78	"
5.55	15.45	"	7.77	11.09	"
6.33	12.84	"	10.60	9.40	"
7.38	10.95	"	11.69	8.03	"
8.74	8.76	"	15.77	10.34	"
9.91	7.41	"	16.78	13.45	"
10.88	6.38	"	17.75	10.74	"
11.50	5.89	" + K	18.42	10.91	" + K
11.46	5.12	K	16.51	8.93	K
10.95	1.42	"	13.39	5.20	"
10.71	0.0	"	12.31	3.08	"
			10.75	0.00	"

* = Metastable

Be₄ = BeSO₄·4H₂OBe₂ = BeSO₄·2H₂OK = K₂SO₄1.1.2 = BeSO₄·K₂SO₄·2H₂O

(Cont.)

Be BERYLLIUM

THE SYSTEM BERYLLIUM SULFATE - POTASSIUM SULFATE - WATER--Cont.

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	K ₂ SO ₄	BeSO ₄		K ₂ SO ₄	BeSO ₄	
<u>Results at 50°</u>						
SO	0.0	33.22	Be ₄	11.39	8.50	1.1.2
	0.80	32.81	"	13.49	6.54	"
	2.21	32.20	" + 1.1.2	14.76	5.67	"
	3.16	27.94	1.1.2	14.93	5.54	" + K
	4.84	22.16	"	14.87	5.427	K
	6.98	15.94	"	14.45	1.898	"
	8.46	12.89	"	14.16	0.0	"
	10.45	9.70	"			

Results at 75°

0.0	38.62	Be ₄	13.41	10.03	1.1.2
2.63	37.08	"	15.43	7.99	"
3.52	36.73	" + 1.1.2	18.41	5.71	" + K
3.89	33.46	1.1.2	18.25	4.96	K
5.34	27.33	"	17.95	3.56	"
7.20	21.94	"	17.46	1.20	"
10.58	14.11	"	17.17	0.0	"

Results at 99.5°

0.0	43.51	Be ₂	13.66	15.61	1.1.2
2.57	42.26	"	16.71	10.91	"
5.12	41.28	" + 1.1.2	19.42	8.38	"
5.32	39.61	1.1.2	22.17	8.48*	K
6.98	33.60	"	21.68	6.52	K + 1.1.2
8.55	26.97	"	20.71	3.65	"
10.92	21.31	"	19.35	0.0	"

* = Metastable

Be₄ = BeSO₄·4H₂O

Be₂ = BeSO₄·2H₂O

K = K₂SO₄

1.1.2 = BeSO₄·K₂SO₄·2H₂O

THE SYSTEM BERYLLIUM SULFATE - SODIUM SULFATE - WATER
(Schroder, 1938; Schroder, Hompeach and Mirback, 1938)

The authors also give results at 16.5° and 60°, and the densities of all saturated solutions.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Na ₂ SO ₄	BeSO ₄	Solid Phase	Na ₂ SO ₄	BeSO ₄	Solid Phase
Results at 0°			Results at 25°		
0.0	24.72	Be ₄	0.0	29.29	Be ₄
0.31	26.88	"	4.30	27.63	"
0.87	26.67	"	9.42	25.64	"
2.41	26.34	"	13.90	23.90	"
2.93	26.03	" + Na ₁₀	19.38	22.09	"
3.11	23.75	Na ₁₀	18.40	22.21	" + Na
3.41	21.60	"	19.42	20.27	Na
3.81	12.47	"	20.58	17.00	"
4.07	7.39	"	21.53	15.55	" + Na ₁₀
4.20	2.42	"	21.21	11.64	Na ₁₀
4.21	1.21	"	21.32	4.61	"
4.30	0.0	"	21.68	0.0	"

Results at 50°			Results at 75°		
0.0	33.31	Be ₄	0.0	38.96	Be ₄
6.83	31.07	"	4.11	38.01	"
10.33	30.09	"	8.00	36.94	"
15.77	28.46	" + 1.3	10.29	36.42	"
16.39	27.18	1.3	13.38	35.87	" + 1.3
18.04	25.28	"	15.45	32.47	1.3
20.04	23.41	" + Na	18.75	26.63	"
20.58	22.35	Na	20.59	23.31	"
21.67	19.48	"	22.13	21.01	"
24.02	14.81	"	24.75	18.07	" + Na
28.86	5.68	"	25.82	14.40	Na
31.71	0.0	"	27.81	7.54	"
			30.36	0.0	"

Be₄ = BeSO₄·4H₂O
 Be₂ = BeSO₄·2H₂O
 Na₁₀ = Na₂SO₄·10H₂O
 Na = Na₂SO₄
 1.3 = BeSO₄·3Na₂SO₄

(Cont.)

Be BERYLLIUM

THE SYSTEM BERYLLIUM SULFATE - SODIUM SULFATE - WATER--Cont.

SO	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	Na ₂ SO ₄	BeSO ₄		Na ₂ SO ₄	BeSO ₄	
	Results at 86°			Results at 90.5°		
	0.0	42.14	Be ₄	0.0	43.70	Be ₂
	2.62	41.88	"	3.48	42.71	"
	5.72	41.11	"	6.79	41.85	"
	10.21	40.13	"	10.87	40.58	"
	13.32	39.65	" + 1.3	14.82	39.59	" + 1.3
	16.94	31.93	1.3	16.97	34.51	1.3
	18.32	28.87	"	19.53	29.32	"
	21.95	22.36	"	21.76	24.82	"
	25.02	17.30	"	23.98	20.71	"
	26.43	15.54	" + Na	26.51	15.78	"
	25.96	18.53*	Na	27.71	13.69	" + Na
	28.01	8.61	"	28.18	10.29	Na
	30.01	0.0	"	29.68	0.0	"

* = Unstable

Be₄ = BeSO₄·4H₂OBe₂ = BeSO₄·2H₂ONa = Na₂SO₄1.3 = BeSO₄·3Na₂SO₄THE SYSTEM BERYLLIUM SULFATE - COPPER SULFATE - WATER
(Novossjolova, Rodaljova and Guenstein, 1938)

Results at 30°			Results at 80°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuSO ₄	BeSO ₄		CuSO ₄	BeSO ₄	
0.0	29.99	BeSO ₄ ·4H ₂ O	0.0	39.82	BeSO ₄ ·4H ₂ O
1.18	29.07	"	1.0	39.80	"
1.89	28.50	"	8.13	34.73	"
3.37	27.76	"	10.15	33.65	"
3.97	27.58	"	14.20	31.05	"
5.17	26.39	" + CuSO ₄ ·5H ₂ O	15.47	30.40	" + CuSO ₄ ·5H ₂ O
7.34	22.15	CuSO ₄ ·5H ₂ O	19.11	23.87	CuSO ₄ ·5H ₂ O
8.48	20.60	"	23.05	18.52	"
13.94	10.81	"	27.48	11.63	"
16.81	4.67	"	31.63	5.84	"
18.04	2.54	"	33.81	3.79	"
18.92	1.08	"	34.26	2.25	"
19.86	0.0	"	35.54	0.0	"

THE SYSTEM BERYLLIUM SULFATE - FERROUS SULFATE - WATER
(Novoselova, Varobeva, Knyazeva and Paskutskaya, 1953)

Density $\frac{g}{cm^3}$	Results at 25°			Results at 60°		
	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	BeSO ₄	FeSO ₄		BeSO ₄	FeSO ₄	
1.285	28.72	0.0	BeSO ₄ ·4H ₂ O	0.0	34.94	FeSO ₄ ·4H ₂ O
1.306	25.53	3.59	"	8.82	25.56	"
...	24.11	6.54	"	13.58	21.05	"
1.340	24.00	8.09	" + FeSO ₄ ·7H ₂ O	14.56	20.60	"
1.312	21.31	10.72	FeSO ₄ ·7H ₂ O	20.20	16.68	" + BeSO ₄ ·4H ₂ O
1.300	17.19	11.60	"	20.40	16.70	"
1.296	12.23	14.17	"	20.42	16.50	"
1.282	5.73	18.39	"	23.68	10.38	BeSO ₄ ·4H ₂ O
1.270	0.0	22.74	"	26.70	7.75	"
				27.21	6.60	"
				34.60	0.0	"

30

THE SYSTEM BERYLLIUM SULFATE - MANGANOUS SULFATE - WATER AT 25°
(Vorobeveva and Osanov, 1953)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Density	Sat. Sol.
BeSO ₄	MnSO ₄		BeSO ₄	MnSO ₄		Mole% MnSO ₄ in Sat. Sol.	$\frac{g}{cm^3}$
28.7	0.0	Be ₄	13.66	25.41	Mn ₅	0.0	1.279
25.14	4.84	"	7.40	30.05	"	11.80	1.316
23.14	10.03	"	5.25	33.00	"	23.08	1.358
20.67	15.09	"	0.0	39.37	"	33.55	1.384
18.64	18.03	"	7.48	29.90	Mn ₄	40.20	1.407
17.00	21.39	"	14.89	24.44	"	46.68	1.430
17.29	21.22	" + Mn ₅				56.37	1.455
						73.97	1.476
						100	1.500

Be₄ = BeSO₄·4H₂OMn₅ = MnSO₄·5H₂OMn₄ = MnSO₄·4H₂O

Be BERYLLIUM

THE SYSTEM BERYLLIUM SULFATE - ZINC SULFATE - WATER (Schröder, 1936)

Data are also given at 33°, 37° and 86°.

	Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
	ZnSO ₄	BeSO ₄	Density		ZnSO ₄	BeSO ₄	Density	
SO	Results at 0°				Results at 50°			
	0.0	27.10	1.2682	Be ₄	0.0	33.78	1.3340	Be ₄
	2.01	25.67	1.2770	"	2.11	32.50	1.3440	"
	4.91	23.85	1.3015	"	7.79	28.31	1.3760	"
	11.36	19.77	1.3518	"	16.28	23.06	....	"
	12.03	19.70	1.3565	" + Zn ₇	23.15	18.71	1.5021	" + Zn ₇
	14.19	16.59	1.3495	Zn ₇	23.29	18.59	1.5031	" + Zn ₇
	19.92	9.71	1.3546	"	26.82	16.48	1.5477	Be ₄ + Zn ₆
	24.83	4.47	1.3666	"	26.01	15.70	1.5187	Zn ₁
	27.79	1.56	1.3732	"	29.88	12.12	1.5369	"
	29.58	0.0	1.3796	"	37.18	5.69	1.5781	"
					39.01	4.35	1.5901	" + Zn ₆
					37.88	5.41	1.5870	Zn ₆
	0.0	29.83	1.3020	Be ₄	41.64	1.70	1.5874	"
	4.93	26.50	1.3288	"	43.28	0.0	1.6048	"
	10.46	22.83	1.3642	"				
	17.75	18.32	1.4198	"	Results at 99°			
	21.31	16.49	1.4560	" + Zn ₇	0.0	43.70	1.4025	Be ₂
	21.51	16.29	1.4550	"	11.52	42.75	1.4281	"
	21.68	16.03	1.4555	Zn ₇	2.61	41.89	1.4344	"
	23.09	14.27	1.4571	"	5.32	40.14	1.4560	"
	23.79	13.34	1.4578	"	6.23	39.51	1.4598	" + Zn ₁
	28.09	8.66	1.4671	"	7.24	35.39	1.4561	Zn ₁
	31.83	4.58	1.4765	"	8.79	33.75	1.4440	"
	34.98	1.64	1.4860	"	15.78	23.77	....	"
	36.67	0.0	1.4921	"	22.85	15.26	1.4361	"
					30.73	6.76	1.4451	"
					35.46	2.08	1.4521	"
					37.70	0.0	1.4623	"

SOLUBILITY OF BERYLLIUM SULFATE IN METHANOL AND ETHANOL (Barber and Ali, '950)

Solid taken	- Gms. per liter sat. sol. -			
	Solvent 98% Methanol		Solvent 96% Ethanol	
	Room temp.	boiling point	Room temp.	Boiling point
BeSO ₄	0.47	1.6	6.10	31.3
BeSO ₄ .4H ₂ O	2.15	220.	0.60	44.

BERYLLIUM SELENATE $\text{BeSeO}_4 \cdot 4\text{H}_2\text{O}$

SeO

SOLUBILITY OF BERYLLIUM SELENATE IN AQUEOUS SOLUTIONS
CONTAINING BERYLLIUM OXIDE AT 25°
(Sidgwick and Lewis, 1926)

Gms. per 100 gms. sat. solution		
BeSeO_4	BeO	Solid Phase
36.22	0.046	$\text{BeSeO}_4 \cdot 4\text{H}_2\text{O}$
37.05	0.60	"
38.84	1.98	"
40.23	2.98	"
42.11	3.71	"

BERYLLIUM MetaVANADATE $\text{Be}(\text{VO}_3)_2 \cdot 4\text{H}_2\text{O}$

VO

100 gms. H_2O dissolve 0.1 gm. of the salt at 25°. (Brinton, 1916).

Bi BISMUTH

Bi BISMUTH

SOLUBILITY OF Bi IN BiCl₃

320° - 46.6 mole% Bi in sat. sol. (Eggink, 1908)

450° - 47.5 " " " " " (Cleary and Cubicciotti, 1952)

See also Sokolova, Urazov and Kuznetsov, 1954. Cleary and Cubicciotti also determined the solubility of bismuth in BiCl₃ + CuCl, BiCl₃ + ZnCl₂, BiCl₃ + NaCl, and BiCl₃ + CaCl₂ mixtures.

Melting points in the system Bi + BiI₃ are given by Urazov and Masokolova, 1954.

The reaction $2\text{Bi} + 3\text{PbF}_2 \rightleftharpoons 3\text{Pb} + 2\text{BiF}_3$ was studied at 850° by Jellinek (1944), and $2\text{Bi} + 3\text{PbO} \rightleftharpoons \text{Bi}_2\text{O}_3 + 3\text{Pb}$ at 1100° by Jellinek and Siewers, 1932.

Data are given for the systems:

Bismuth + Bromine (Eggink, 1908)

" + Chlorine(")

" + Iodine (Amadori and Becarelli, 1912; Urazov and Sokolova, 1954)

" + Sulfur (Aten, 1905; Palabon, 1904)

MUTUAL SOLUBILITY OF BISMUTH AND ZINC

(Spring and Romanoff, 1906)

t°	Upper Layer		Lower Layer		t°	Upper Layer		Lower Layer	
	%Bi	%Zn	%Bi	%Zn		%Bi	%Zn	%Bi	%Zn
266	86	14	..	..	584	80	20	10	90
419	..	..	3	97	650	77	23	15	85
475	84	16	5	96	750	70	30	27	73
810-820 (crit. temp.)									

Data for the solubility of a large number of elements in metallic bismuth is given by Ivanov and Regel, 1955.

Br BISMUTH BROMIDE BiBr₃

The system BiBr₃ + Trinitrotoluene was studied by Pushin, Nikolic, et. al. (1947).

The system BiBr₃ + Nitrobenzene was studied by Pushin (1948a).

Fusion point data for mixtures of BiBr₃ + SbBr₃ are given by Pušin and Makuc, 1938.

BISMUTH oxyBROMIDE BiOBr

Br

SOLUBILITY IN HNO₃ AND KBr SOLUTIONS AT 25°
(Yatsimirskii, 1953)

In aq. HNO ₃				In aq. KBr + 1.003 M HNO ₃			
moles per liter		moles per liter		moles per liter		moles per liter	
HNO ₃	BiOBr (x 10 ⁻³)	HNO ₃	BiOBr (x 10 ⁻³)	HNO ₃	BiOBr (x 10 ⁻²)	HNO ₃	BiOBr (x 10 ⁻²)
0.1063	0.066	1.4390	7.259	0.0498	0.451	0.5814	11.87
0.3036	0.356	1.6218	10.004	0.1007	1.170	0.6906	13.86
0.5195	0.934	1.8053	13.50	0.2008	2.312	0.7977	15.71
0.6925	1.612	2.0733	24.21	0.3048	3.563	0.8927	17.81
1.0755	3.674	2.1817	28.35	0.4018	6.160	0.9719	19.14
1.2057	4.705	2.5288	40.89	0.4980	7.834	1.1616	21.56

BISMUTH CITRATE (CH₂)₂C(OH)(COO)₃Bi

CH

BISMUTH Ammonium CITRATE

SOLUBILITY OF EACH IN WATER AND IN AQUEOUS ETHYL ALCOHOL AT 25°
(Seidell, 1910)

Citrate		Ammonium Citrate		
Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. C ₆ H ₅ O ₇ Bi per 100 Gms. Sat. Sol.	Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. Bi.NH ₄ Citrate per 100 Gms. Sat. Sol.	d ₂₅ Sat. Sol.
0	0.011	0	22.25	1.25
51	0.041	51	1.34	0.92
91.4	0.065	91.4	None	0.81

BISMUTH CUPFERRATE Bi(C₆H₅N(NO)O)₃ (NITROSO-p-Phenyl hydroxylamine)

CH

SOLUBILITY IN WATER AT 18°

0.0004 gms. per liter	(Martin)
0.0084 " " "	(Martin and Pinkus, 1927)
K _{sp} = 6 x 10 ⁻²⁸	(Pyatnitski, 1946)

Bi BISMUTH

CH BISMUTH LACTATE $C_6H_9O_6Bi \cdot 7H_2O$

The solubility of the hydrate in water at 25°, is 12.6 gms. per 100 gms. sat. solution.

The solubility of the anhydrous salt is 1.6 gms. per 100 gms. sat. sol. (Moles and Portillo, 1924).

CH BISMUTH TRIPHENYL $Bi(C_6H_5)_3$

Fusion point data are given for mixtures of bismuth triphenyl and mercury diphenyl by Cambi (1912).

CH Basic BISMUTH SALICYLATE ($64\%Bi_2O_3$)

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°
(Seidell, 1910)

Gms. C_2H_5OH per 100 Gms. Solvent	Gms. Salt per 100 Gms. Sat. Sol.	Gms. C_2H_5OH per 100 Gms. Solvent	Gms. Salt per 100 Gms. Sat. Sol.
0	0.010	80	0.065
20	0.015	90	0.095
40	0.022	92.3	0.105
60	0.036	100	0.160

CH BISMUTH OXINE $Bi_2(C_9H_6ON)_3$ (8-hydroxyquinolate)

The mole fraction of $Bi_2(C_9H_6ON)_3$ in a saturated solution in dioxane is 0.000428 at 25°. (Charles and Freiser, 1951).

At pH 4.0-5.2 extraction of the compound by $CHCl_3$ from aqueous solutions is "complete." (Moetter, 1943).

CH BISMUTH OLEATE $Bi(C_{18}H_{33}O_2)_3$

BISMUTH PALMITATE $Bi(C_{16}H_{31}O_2)_3$

BISMUTH STEARATE $Bi(C_{18}H_{35}O_2)_3$

SOLUBILITY IN TRANSFORMER OIL
(Nikitina and Maksimova, 1949)

t°	Gms. per 100 gms. solvent		
	Bi oleate	Bi palmitate	Bi stearate
30	0.16	0.31	0.45
70	0.45	0.84	0.72

BISMUTH OXALATES Neutral = $\text{Bi}_2(\text{C}_2\text{O}_4)_3$ Basic = $\text{Bi}(\text{OH})\text{C}_2\text{O}_4$

CO

SOLUBILITY IN AQUEOUS SOLUTIONS OF NITRIC ACID
(Keschau, 1925)

A hot saturated solution of bismuth oxalate in 5.0 n HNO_3 was diluted with H_2O to desired concentrations. A very slow crystallization occurs. After 3 days the saturated solutions were analyzed and the following results obtained.

Milligram-Equivalents per liter of solution made with:

Normality of the aq. HNO_3	$\text{Bi}_2(\text{C}_2\text{O}_4)_3$		$\text{Bi}(\text{OH})\text{C}_2\text{O}_4$	
	C_2O_4	Bi	C_2O_4	Bi
4.0	25.8	24.7	21.3	46.2
3.0	13.5	12.7	8.5	22.5
2.0	6.0	5.4	3.8	14.2
1.0	1.9	1.5	1.2	3.7
0.5	0.7	0.5	0.4	0.7

BISMUTH oxyTHIOCYANATE BiOSCN

CNS

The K_{sp} of BiOSCN is 1.6×10^{-7} . (Hubicki and Dabkowska, 1950).

BISMUTH CHLORIDE BiCl_3

Cl

BISMUTH oxyCHLORIDE BiOCl

EQUILIBRIUM IN THE SYSTEM BISMUTH OXIDE, HYDROCHLORIC ACID AND WATER

In the case of the results at 18° , the saturated solutions were prepared by adding sufficient H_2O to solutions of Bi_2O_3 in 0.1 n HCl until BiOCl precipitated, and the mixtures were shaken repeatedly for 18-20 hours. For the results at 25° the constituents were constantly shaken in sealed tubes.

Feitknecht (1933) calculates the K_{sp} of BiOCl to be $1.48 - 2.74 \times 10^{-31}$ at 18° from the data below. By polarography, Filipovic (1951) found $K_{sp} = 1 \times 10^{-34}$ at room temperature.

Bi BISMUTH

EQUILIBRIUM IN THE SYSTEM BISMUTH OXIDE, HYDROCHLORIC ACID AND WATER--Cont.

Results at 18° (Jellinek and Kuhn, 1923)			Results at 25° (Waris, 1925)		
Mols. per 100 mols. H ₂ O		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HCl	Bi ₂ O ₃		HCl	Bi ₂ O ₃	
0.71	0.0018	BiOCl	2.50	0.6	BiOCl
0.74	0.0021	"	4.22	2.50	"
0.89	0.0056	"	10.68	11.40	"
0.18	0.0135	"	13.43	16.41	"
1.28	0.0247	"	18.47	26.42	"
1.36	0.0315	"	30.23	50.74	"
2.20	0.1185	"	33.67	58.72	BiCl ₃
3.81	0.2835	"	35.14	58.59	"

SOLUBILITY OF BISMUTH CHLORIDES IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 25° (Noyes and Hall, 1917)				Results at 30° (Jacobs, 1917)		
d ₄ ²⁵ of Sat. Sol.	Gms. Atoms per 1000 Gms. H ₂ O			Gms. per 100 Gms. Sat. Sol.		Solid Phase
	Cl	Bi	H(=Cl-3Bi)	Bi ₂ O ₃	HCl	
1.002	0.3477	0.00130	0.3438	0.60	2.40	BiOCl.H ₂ O
1.007	0.4350	0.00376	0.4237	5.35	5.69	"
1.010	0.5221	0.00869	0.4960	8.17	8.47	"
1.013	0.6244	0.01767	0.5714	8.70	8.93	"
1.018	0.7375	0.03138	0.6434	14.52	13.02	"
1.025	0.8824	0.05338	0.7223	18.60	15.80	"
1.036	1.0760	0.08937	0.8079	30.10	21.7	"
1.044	1.2277	0.1177	0.8746	36.95	25.4	"
1.061	1.5321	0.1810	0.9891	54.70	31.5	"
1.083	1.9021	0.2657	1.105	56	32.8	BiOCl
1.157	3.1865	0.5685	1.481	58.5	33	BiCl ₃ .2H ₂ O
1.237	4.5056	0.9022	1.799	56.6	33.8	" + BiCl ₃
1.288	5.325	1.100	2.025	56.25	34.9	BiCl ₃
1.329	6.066	1.317	2.115	55.9	35.9	BiCl ₃ .HCl

SOLUBILITY OF BiOCl IN AQUEOUS HNO_3 AND KCl SOLUTIONS AT 25°
(Yatsimirskii, 1953)

In aq. HNO_3				In aq. $\text{KCl} + 1.003 \text{ M } \text{HNO}_3$			
moles per liter		moles per liter		moles per liter		moles per liter	
HNO_3	BiOCl ($\times 10^{-3}$)	HNO_3	BiOCl ($\times 10^{-3}$)	KCl	BiOCl ($\times 10^{-3}$)	KCl	BiOCl ($\times 10^{-3}$)
0.1063	0.066	1.4390	5.533	0.0202	0.948	0.4002	10.10
0.3036	0.333	1.6218	7.263	0.0494	0.933	0.4964	28.75
0.5195	0.678	1.8053	9.230	0.0588	1.324	0.5860	51.65
0.6925	1.335	2.0733	12.90	0.0794	1.484	0.7015	69.59
1.0755	2.868	2.1817	15.34	0.0990	2.901	0.8004	81.34
1.2057	3.763	2.5288	24.05	0.1496	4.688	0.8959	97.81
				0.0216	5.504	0.9852	111.04
				0.2990	10.40		

Data for the systems $\text{BiCl}_3 + \text{NaCl} + \text{H}_2\text{O}$ and $\text{Bi}_2\text{O}_3 + \text{HCl} + \text{H}_2\text{O}$ at room temperature are given by Kern and Jones, 1930.

SOLUBILITY OF BISMUTH CHLORIDE AND BISMUTH OXYCHLORIDE
IN SEVERAL SOLVENTS

Solvent	t°	Gms. BiCl_2 per 100		Authority
		cc. Solvent	Gms. Solvent	
Acetone	18°	...	17.9 ($d_{18} = 0.9194$)	(Naumann, 1904, '05)
Ethyl Acetate	18°	...	1.66 ($d_{18} = 0.9106$)	(Naumann, 1910)
Anhydrous Hydrazine	"ord. temp."	32	...	(Welsh and Broderick, 1915)
95% Formic Acid	19.8	...	0.05*	(Ashcan, 1913)

* BiOCl

Melting point data are given for

$\text{BiCl}_3 + \text{CuCl}$	(Herrmann, 1911)
+ FeCl_3	(")
+ PbCl_2	(")
+ PbBr_2	(")
+ ZnCl_2	(") (Jänecke, 1933)
+ TiCl	(Scarpa, 1912)
+ SbCl_3	(Starckadomska, 1939)

Bi BISMUTH

I BISMUTH IODIDE BiI_3

Data for the following systems are presented by the authors in the form of diagrams but the analytical results from which the diagrams were drawn are not given.

$\text{BiI}_3 + \text{KI} + \text{H}_2\text{O}$ at 15° , 35° and 55° . There are four branches of the solubility curve at each of the three temperatures, corresponding respectively to the solid phases, BiI_3 , $\text{BiI}_3 \cdot \text{KI} \cdot \text{H}_2\text{O}$, $\text{BiI}_3 \cdot 2\text{KI} \cdot \text{H}_2\text{O}$ and KI . (Delwaulle, 1934; Francois and Delwaulle, 1936).

$\text{BiI}_3 + \text{LiI} + \text{H}_2\text{O}$ at 12° , 35° and 60° . There are three branches of the solubility curve at each of the three temperatures corresponding respectively to the solid phases, BiI_3 , $\text{BiI}_3 \cdot \text{LiI} \cdot 6\text{H}_2\text{O}$ and LiI . (Francois and Delwaulle, 1936).

$\text{BiI}_3 + \text{NH}_4\text{I} + \text{H}_2\text{O}$ at 11° , 35° and 50° . There are five branches of the solubility curve at each of the three temperatures corresponding respectively to the solid phases: BiI_3 , $\text{BiI}_3 \cdot \text{NH}_4\text{I} \cdot 2\text{H}_2\text{O}$, $\text{BiI}_3 \cdot 2\text{NH}_4\text{I} \cdot 2\text{H}_2\text{O}$, $\text{BiI}_3 \cdot 4\text{NH}_4\text{I} \cdot 2\text{H}_2\text{O}$ and NH_4I . (Delwaulle, 1935; Francois and Delwaulle, 1936).

$\text{BiI}_3 + \text{NaI} + \text{H}_2\text{O}$ at 12° , 32° and 60° . There are four branches of the solubility curve at each of the three temperatures corresponding respectively to the solid phases. BiI_3 , $\text{BiI}_3 \cdot \text{NaI} \cdot 6\text{H}_2\text{O}$, $\text{BiI}_3 \cdot 2\text{NaI} \cdot 8\text{H}_2\text{O}$ and NaI . (Francois and Delwaulle, 1936).

$\text{BiI}_3 + \text{RbI} + \text{H}_2\text{O}$ at 12° . There are four branches of the solubility curve corresponding respectively to the solid phases BiI_3 , $\text{BiI}_3 \cdot 1\frac{1}{2}\text{RbI}$, $\text{BiI}_3 \cdot 3\text{RbI}$ and RbI . (Delwaulle, 1936).

Data for the extraction of BiI_3 from aqueous HCl solution by ether are given by Kitahara, 1948.

SOLUBILITY OF BISMUTH IODIDE IN NONAQUEOUS SOLVENTS

Solvent	t°	Gms. BiI_3 per 100 gms. solvent	Author
Absolute alcohol	20°	3.5	(Gott and Muir, 1888)
Methylene iodide	12°	0.15	(Retgers, 1893)
Hydrogen fluoride	-23.1	0.010	(Jache and Cady, 1952)
"	-8.3	0.011	(")
"	$+12.4$	0.010	(")

BISMUTH Quinine IODIDE (Quinine Iodo bismuthate) $(\text{BiI}_3)_2\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot 2\text{HI}$ 1SOLUBILITY OF COMPLETELY DRIED QUININE IODO BISMUTHATE
IN HIGHLY PURIFIED ACETONE
(Picon, 1934)

Very small quantities of water increase considerably the amount of the compound dissolved. Furthermore, even with perfectly dried constituents two liquid layers are formed. The lighter one contains very little quinine Iodo bismuthate, while the more dense one corresponds to a liquid combination of the solvent and solid. The compound has the composition $(\text{BiI}_3)_2\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot 2\text{HI} \cdot 6\text{CH}_3\text{COCH}_3$. The failure of the compound to crystallize increases the difficulty of the experiment. The solubility decreases in the lighter layer with increase of temperature.

t°	<u>Lighter Layer</u>		<u>Heavier Layer</u>	
	d	Gms. $(\text{BiI}_3)_2\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot 2\text{HI}$ per 100 cc. sat. sol.	d	Gms. $(\text{BiI}_3)_2\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot 2\text{HI}$ per 100 cc. sat. sol.
9	0.8159	2.64	1.473	94.2
19	0.8063	1.97	1.544	104.9
29	0.7981	1.54	1.609	115.3
39	0.7882	1.11	1.673	123.2
49	0.7793	0.80	1.732	130.2

The following results were obtained with commercial samples of quinine Iodo bismuthate.

19	0.809	3.31	...	...
19	0.818	4.7	...	...
19	0.842	6.52	1.534	103.6
*19	0.939	20.08	1.314	72.64

*In this case 0.5% H_2O was present in the acetone.

BISMUTH MOLYBDATE $\text{Bi}_2(\text{MoO}_4)_3$ MoO

Melting points are given for the system $\text{Bi}_2(\text{MoO}_4)_3 + \text{PbMoO}_4$ by Zambonini, 1920.

BISMUTH oxyNITRITE BiONO_2 NO

Hubicki and Dabkowska, 1950 found the K_{sp} to be 4.9×10^{-7} . The salt is white.

Bi BISMUTH

NO BISMUTH NITRATE $\text{Bi}(\text{NO}_3)_3$

SOLUBILITY OF BISMUTH NITRATE IN AQUEOUS NITRIC ACID AND IN AQUEOUS NITRIC ACID CONTAINING ACETONE, AT ORDINARY TEMPERATURE
(Dubrissay, 1911)

Solvent	Gms. $\text{Bi}(\text{NO}_3)_3$ per per 100 cc. sat. sol.	Solid Phase
0.922 n HNO_3	86.86	$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$
0.922 " " + 6.66% Acetone	85.51	"
0.922 " " + 13.33% " "	81.96	"
2.3 " "	80.37	"
2.3 " " + 16.66% " "	74.47	"

SOLUBILITY IN ACETONE

100 gms. of acetone dissolve 48.66 gms. $\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$ at 0° and 41.7 gms. at 19° . (von Laszczynski, 1894)

SOLUBILITY IN ETHER

At 20° , 80 gms. $\text{Bi}(\text{NO}_3)_3$ dissolve in one liter of ether, solid phase $\text{BiNO}_3 \cdot 5\text{H}_2\text{O}$. The distribution coefficient (ether: H_2O) is 0.046. (Bachelet, Cheylant and LeBris, 1950).

The extraction of $\text{Bi}(\text{NO}_3)_3$ by ether from aqueous solutions containing NH_4CNS and HCl has been studied by Bock, 1951.

SOLUBILITY OF DOUBLE NITRATES OF BISMUTH AND MAGNESIUM, NICKEL, COBALT, ZINC AND MANGANESE IN CONC. HNO_3 AT 16°
(Jantsch, 1912)

(d_{16} of HNO_3 = 1.325, 100 cc. of this acid contained 51.59 gms. HNO_3 .)

Double Salt	Gms. Hydrated Salt per 100 cc. Sat. Solution	Double Salt	Gms. Hydrated Salt per 100 cc. Sat. Solution
$\text{Bi}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	41.69	$\text{Bi}_2\text{Zn}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	57.51
$\text{Bi}_2\text{Ni}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	46.20	$\text{Bi}_2\text{Mn}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	65.77
$\text{Bi}_2\text{Co}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	54.67		

BISMUTH OXYNITRATE BiONO_3 $\text{BiOOH} \cdot \text{BiONO}_3$

NO

SOLUBILITY OF BISMUTH OXYNITRATE IN AQUEOUS SOLUTIONS
OF NITRIC ACID AT 25°

(Swinehart and Garrett, 1951; Smith, 1923a)

S.&G.		S.&G.		Smith		
Solid phase BiONO_3		Solid Phase $\text{BiONO}_3 \cdot \text{BiOOH}$		Solid Phase BiONO_3		
a_H (glass electrode)	Moles Bi per 1000 gms. H_2O	a_H (glass electrode)	Moles Bi per 1000 gms. H_2O	d_{25} of sat. sol.	Gm. mols. per liter sat. sol.	
					Bi	NO_3
0.0250	$32(x 10^{-5})$	0.0042	$1.45(x 10^{-5})$	1.0005	0.002713	0.1027
.0300	39	.0064	1.86	1.0067	0.01449	0.2168
.0350	51	.014	3.88	1.0228	0.04944	0.4485
.0400	65	.020	5.85	1.0422	0.09956	0.6969
.0450	81	.022	7.16	1.0643	0.1592	0.9537
.0500	99	.028	14.0	1.0912	0.2351	1.2547
.0600	140	.035	14.3			
.0700	194	.038	23.3			
.0800	261	.040	26.4			
.0900	342	.046	31.5			
.100	430	.049	33.8			
.110	522	.049	73.9			
.120	616	.051	45.4			
.130	715	.051	65.1			
.150	920	.051	82.9			

BISMUTH OXIDE Bi_2O_3

O

BISMUTH HYDROXIDE $\text{Bi}(\text{OH})_3$

OH

SOLUBILITY OF BISMUTH HYDROXIDE IN WATER
(Almkvist, 1918)

Ordinary distilled water containing a little CO_2 was used. The $\text{BiO}(\text{OH})$ was therefore, probably converted to basic carbonate. Two liters of the saturated solution were used for the analysis. After constant stirring at approximately 20°, there was found 0.00144 gms. $\text{BiO}(\text{OH})$ per liter.

Bi BISMUTH

SOLUBILITY OF BISMUTH OXIDE IN AQUEOUS NITRIC ACID AT 20° (Rutten and van Bemmelen, 1902)

Present in Shaker Flask Per 1 part	Gms. per 100 Gms. Solution		Mols. per 100 Mols. H ₂ O			Solid Phase
	Bi ₂ O ₃	N ₂ O ₅	Bi ₂ O ₃	N ₂ O ₅	Ratio Bi ₂ O ₃ :N ₂ O ₅	
Bi ₂ O ₃ .2N ₂ O ₅ .10H ₂ O						
24.4 parts H ₂ O	0.321	0.963	0.126	1.61	1:12.8	Bi ₂ O ₃ .N ₂ O ₅ .2H ₂ O
3.2 parts H ₂ O	6.37	7.17	2.844	13.82	1: 4.8	
Dilute HNO ₃	18.74	15.9	10.50	38.65	1: 3.6	Bi ₂ O ₃ N ₂ O ₅ .H ₂ O
Dilute HNO ₃	31.48	23.7	27.2	83.8	1: 3.0	
Dilute HNO ₃ = 6.13% N ₂ O ₅	32.93	24.83	30.15	97.97	1: 3.2	{ Bi ₂ O ₃ .N ₂ O ₅ .H ₂ O and Bi ₂ O ₃ .3N ₂ O ₅ .10H ₂ O
6.816% N ₂ O ₅	32.67	24.70	29.70	96.57	1: 3.2	
24.0% N ₂ O ₅	24.16	28.25	19.65	98.76	1: 5.0	Bi ₂ O ₅ .3N ₂ O ₅ .10H ₂ O
OH 51.0% N ₂ O ₅	11.66	46.62	10.81	186.23	1:17.2	
70.0% N ₂ O ₅	20.76	53.75	33.51	355.87	1:10.6	
	27.85	51.02	51.0	403.0	1: 7.9	{ Bi ₂ O ₃ .3N ₂ O ₅ .10H ₂ O and Bi ₂ O ₃ .3N ₂ O ₅ .3H ₂ O
Anhydrous HNO ₃	8.56	68.28	14.35	492.0	1:34.3	
Bi ₂ O ₃ + "	4.05	74.90	7.45	592.9	1:79.5	Bi ₂ O ₃ .3N ₂ O ₅ .3H ₂ O

Results are also given for 9°, 30°, and 65°.

SOLUBILITY OF BISMUTH OXIDE IN SODIUM HYDROXIDE SOLUTIONS (Schumb and Rittner, 1943)

The authors prepared the α , β , and γ forms of Bi₂O₃ and determined their relative stability at 25° and 100°. At 100° β - and γ -Bi₂O₃ were both converted to α -Bi₂O₃ upon standing in contact with a 2N sodium hydroxide solution in a sealed platinum crucible. At 25° the β -Bi₂O₃ was changed to α -Bi₂O₃ after rotation with sodium hydroxide in a thermostat. In order to determine whether or not the γ -Bi₂O₃ was stable with respect to α -Bi₂O₃, careful solubility measurements were made and the α -Bi₂O₃ was then found to be stable at 25° as well as at 100°.

Results at 25°

Gms. per liter sat. sol.		Solid Phase
NaOH	Bi ₂ O ₃	
20.0	0.0063	α -Bi ₂ O ₃
39.6	.012	"
56.4	.016	"
78.8	.023	"
98.4	.0290	"
56.8	.0190	γ -Bi ₂ O ₃

SOLUBILITY OF BISMUTH HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM
AND POTASSIUM HYDROXIDES AT 20° AND AT 100°
(Moser, 1909)

Gms. KOH per Liter	Gms. Dissolved Bi(OH) ₃ per Liter at:		Gms. NaOH per Liter	Gms. Dissolved Bi(OH) ₃ per Liter at:	
	20°	100°		20°	100°
28	0	0.188	20	0	0.188
50	trace	0.249	40	trace (0.0014)*	0.249
112	0.037	0.373	80	0.050 (0.0029)*	0.436
168	0.074	...	120	0.087 (0.0054)*	0.622 OH
224	0.100	0.622	160	0.100	...
280	0.124	0.622	200	0.124	0.622
336	0.137	...	240	0.137	...
448	0.137	1.494	320	0.137	1.494
560	0.174	2.054	400	0.199	2.120

*Results at 25° by Knox (1909).

At 100° some Bi(OH)₃ was converted into BiO(OH).

SOLUBILITY OF BISMUTH HYDROXIDE IN AQUEOUS SOLUTIONS OF POTASSIUM
CHLORIDE AND OF POTASSIUM BROMIDE AT 30°
(Herz and Bulla, 1909)

(An excess of bismuth hydroxide, prepared according to Moser and having the composition corresponding to BiO.OH, was shaken 2-3 weeks at 30° with aqueous KCl and KBr. The analyses of the sat. solutions are expressed in terms of millimols KOH and KCl or KBr. They have been calculated for the following table to gms. BiO.OH and KCl or KBr.)

Solvent	Gms. per 100 cc. Sat. Sol.		Solvent	Gms. per 100 cc. Sat. Sol.	
	BiO.OH	KCl		BiO.OH	KCl
2 n KCl	3.759	13.75	1 n KBr	8.555	7.67
3 n KCl	5.745	20.71	2 n KBr	17.785	15.02

BISMUTH PHOSPHATE BiPO₄

PO

THE SOLUBILITY OF BISMUTH PHOSPHATE IN AQUEOUS
SOLUTIONS OF HYDROCHLORIC ACID AT 25°
(Jansen, 1934)

The BiPO₄ was prepared by adding a hot solution of Na₂HPO₄ to a hot nitric acid solution of BiONO₃. The precipitated BiPO₄ was washed with dilute HNO₃ and water and dried at 100°. It is very slightly soluble in aqueous NaCl, but upon the addition of very small amounts of free acid the solubility is extraordinarily increased.

A series of determinations were made of the solubility of BiPO₄ in aqueous solutions containing fixed amounts of HNO₃ and H₃PO₄ with increasing amounts of NaCl. In one case fixed amounts of HNO₃ and NaCl and increasing amounts of H₃PO₄ were employed. The results show that a solubility of BiPO₄ is approximately proportional to the third power of the chloride ion concentration and the second power of the hydrogen ion

Bi BISMUTH

THE SOLUBILITY OF BISMUTH PHOSPHATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°--Cont.

and independent of the phosphoric acid concentration. It therefore, follows that the reaction occurring in the solution of bismuth phosphate in hydrochloric acid is primarily, $\text{BiPO}_4 + 2\text{H} + 3\text{Cl} \longrightarrow \text{Bi} \left[\begin{smallmatrix} \text{Cl}_3 \\ \text{H}_2\text{PO}_4 \end{smallmatrix} \right]^-$

Zharovskii (1951) gives the solubility product $\text{Bi}^{+++} \text{PO}_4^{---} = 1.3 \times 10^{-23}$ at 18-20°.

S BISMUTH SULFIDE Bi_2S_3

Goatee, Gorden and Faux (1952) estimate the K_{sp} to be 10^{-96} and believe that the lower value suggested by Kapustinskii (1940) (7.1×10^{-61}) was due to an error in calculation. Measurements of the IMF of the cell $\text{Bi}, \text{Bi}_2\text{S}_3, \text{S} = \parallel$ calomel have led to the calculated values 1×10^{-91} (Bruner and Zowadski, 1910), 1.6×10^{-72} (Kolthoff, 1931) as well as those above. There is some doubt as to the cell reaction involved.

SOLUBILITY OF BISMUTH SULFIDE IN AQUEOUS ALKALI SULFIDE SOLUTIONS AT 25° (Knox, 1909)

Solvent	Gms. Bi_2S_3 per 100 cc. Sat. Solution _s	Solvent	Gms. Bi_2S_3 per 100 cc. Sat. Solution
0.5 n Na_2S	0.0040	0.5 n $\text{Na}_2\text{S} + 1$ n NaOH	0.0185
1.0 n "	0.0238	1 n $\text{Na}_2\text{S} + 1$ n NaOH	0.0838
1.5 n "	0.1023	0.5 n $\text{K}_2\text{S} + 1$ n KOH	0.0240
0.5 n K_2S	0.0043	1 n $\text{K}_2\text{S} + 1$ n KOH	0.1230
1 n "	0.0337	1.25 n $\text{K}_2\text{S} + 1.25$ n KOH	0.2354
1.5 n "	0.0639		

Melting point data are given for the systems:

$\text{Bi}_2\text{S}_3 + \text{Bi}_2\text{Te}_3$	(Amadori, 1915, 1918)
$\text{Bi}_2\text{S}_3 + \text{Bi}_2\text{Te}_3 + \text{Bi}$	(")
$\text{Bi}_2\text{S}_3 + \text{Sb}_2\text{S}_3$	(Vogel and von Massenhausen, 1950)

SO BISMUTH SULFATE $\text{Bi}_2(\text{SO}_4)_3$

EQUILIBRIUM IN THE SYSTEM $\text{Bi}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$ AT 25° (Caglioti and Stolfi, 1927)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Bi}_2(\text{SO}_4)_3$	K_2SO_4		$\text{Bi}_2(\text{SO}_4)_3$	K_2SO_4	
...	2.69	?	...	7.62	$\text{Bi}_2(\text{SO}_4)_3 \cdot 3\text{K}_2\text{SO}_4$
...	4.47	?	...	9.29	"
...	4.50	$\text{Bi}_2(\text{SO}_4)_3 \cdot 3\text{K}_2\text{SO}_4$	...	12.01	"
...	5.32	"	...	12.86	" + K_2SO_4
...	6.34	"			

EQUILIBRIUM IN THE SYSTEM $\text{Bi}_2(\text{SO}_4)_3 + \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$ AT 25°
(Malocasi, 1931)

Gms. per 100 gms. sat. sol.

$\text{Bi}_2(\text{SO}_4)_3$	Li_2SO_4	Solid Phase
0.16	36.20	$\text{Li}_3\text{Bi}(\text{SO}_4)_3 \cdot 2\text{H}_2\text{O}$
0.15	26.10	"
0.15	25.75	$\text{Bi}_2\text{O}_3\text{SO}_3 \cdot \text{Li}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$
0.13	19.52	$\text{Bi}_2\text{O}_3\text{SO}_3 \cdot \text{Li}_2\text{SO}_3 \cdot 2\text{H}_2\text{O}$
0.11	16.79	"
0.09	14.92	"

30

EQUILIBRIUM IN THE SYSTEM $\text{Bi}_2(\text{SO}_4)_3 + (\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{O}$ AT 25°
(Caglioti and Malocasi, 1929)

Gms. per 100 gms. sat. sol.

$\text{Bi}_2(\text{SO}_4)_3$	$(\text{NH}_4)_2\text{SO}_4$	Solid Phase
0.10	23.50	$\text{Bi}_2(\text{OH})_4\text{SO}_4$
0.103	25.27	"
0.107	25.40	" + $\text{Bi}(\text{NH}_4)_3(\text{SO}_4)_3$
0.115	25.50	$\text{Bi}(\text{NH}_4)_3(\text{SO}_4)_3$
0.125	32.52	$\text{Bi}(\text{NH}_4)_3(\text{SO}_4)_3$
0.13	36.37	"
0.14	40.36	"
0.14	41.13	" + $(\text{NH}_4)_2\text{SO}_4$

BISMUTH TITANATE BiTiO_3

TiO

Melting point data are given for mixtures of $\text{BiTiO}_3 + \text{LiF}$, $+ \text{LiCl}$, $+ \text{NaCl}$, $+ \text{KCl}$, $+ \text{K}_2\text{SO}_4$, $+ \text{Na}_2\text{CO}_3$, $+ \text{NaF}$, $+ \text{K}_2\text{MoO}_4$, $+ \text{Pb}(\text{PO}_3)_2$, $+ \text{KF}$, $+ \text{K}_2\text{CO}_3$, $+ \text{NaPO}_3$, $+ \text{Li}_2\text{SiO}_3$, $+ \text{Na}_2\text{SiO}_3$, $+ \text{K}_2\text{SiO}_3$, $+ \text{Li}_2\text{SiO}_3$, $+ \text{Na}_2\text{SiO}_3$, $+ \text{K}_2\text{SiO}_3$, $+ \text{Li}_2\text{SO}_4$, $+ \text{NaSO}_4$, $+ \text{NaVO}_3$, $+ \text{KVO}_3$, $+ \text{Pb}(\text{PO}_3)_2$, $+ \text{Pb}_3(\text{PO}_4)_2$, $+ \text{Na}_2\text{MoO}_4$, $+ \text{BaCl}_2$, $+ \text{NaTiO}_3$, $+ \text{Na}_4\text{P}_2\text{O}_7$, $+ \text{K}_4\text{P}_2\text{O}_7$, $+ \text{KPO}_3$ by Sholokhovich and Belyaev, 1954.

BISMUTH TUNGSTATE $\text{Bi}_2(\text{WO}_4)_3$

WO

Melting point data in the system $\text{Bi}_2(\text{WO}_4)_3 + \text{PbWO}_4$ are given by Zambonini, 1920.

Br BROMINE

BROMINE Br₂

SOLUBILITY IN WATER

(1) D'Ane and Hofer, 1934; (2) Harris, 1932; (3) Jones and Baeckstrom, 1934; (4) Bray and Connolly, 1910; (5) Oliveri-Mandala, 1920; Pearce and O'Leary, 1923; (7) Rhodes and Bascomb, 1927; (8) Winkler, 1899; (9) Zernike, Nawab and Aziz, 1951; (10) McLauchlan, 1903.

The older determinations of Roozeboom, 1884; Dancer, 1862; and Dietze, 1898 are too low. The composition of the hydrate stable at low temperatures is in dispute.

t°	Gms. Br per 100 gms. sat. sol.	Saturating Phase	t°	Gms. Br per 100 gms. sat. sol.	Satu- rating Phase
-0.3(Eutec.)	2.23(1)	Ice + Br ₂ ·8H ₂ O	20.5	3.46(5)	Br ₂
0.0	2.25(1)	Br ₂ ·8H ₂ O	25.0	3.39(6) (10)	"
0.0	2.31(2)	Br ₂ ·10H ₂ O	25.0	3.36(8)	"
0.0	2.33(9)	Br ₂ ·7H ₂ O	25.0	3.42(3)†	"
+3.0	3.08(1)	Br ₂ ·8H ₂ O	25.0	3.36(4)†	"
5.84	3.73(1)	" + Br ₂	30.0	3.32(8)	"
+0.58	4.12(1)*	Ice + Br ₂	30.1	3.341(7)	"
0.0	4.05(1)*d	Br ₂	36.0	3.357(7)	"
0.0	3.98(8)*	"	40.0	3.33(8)	"
+3.0	3.85(1)*	"	41.0	3.387(7)	"
5.0	3.77(8)*	"	44.8	3.414(7)	"
10.0	3.60(1)	"	48.8	3.447(7)	"
10.0	3.61(8)	"	50.0	3.40(8)	"
15.0	3.52(8) †	"	52.8	3.496(7)	"
20.0	3.41(1)	"	53.6(b.pt.)	3.50(7)	"
20.0	3.46(8)	"			

*Metastable.

†Gms. per 100 cc. sat. solution.

^dThe density of a saturated solution of bromine in water at 0° is d₄⁰ = 1.0286, and it has the composition Br₂, 0.2539 mols. per liter; H⁺, 0.001085; Br⁻, 0.000126; Br₃⁻, 0.000628; Br₄⁻, 0.000331.

Data for the distribution of bromine between water and air at 25°, are given by Hantzsch and Vagt (1901).

SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC
AND HYDROBROMIC ACIDS AT 20.8°
(Oliveri-Mandala, 1920)

In Aq. HCl		In Aq. HBr	
Gm. mols. per liter		Gm. mols. per liter	
HCl	Br. (=79.9)	HBr	Br. (=79.9)
1.070	0.4959	0.052	0.2744
1.605	0.6532	0.104	0.3331
2.140	0.8159	0.208	0.4538
2.463	0.928	0.416	0.6809
3.106	1.164	0.832	1.1735
		1.664	2.1293

SOLUBILITY OF BROMINE IN AQUEOUS SULFURIC ACID AT 25°
(Wildeman)

Gms. H_2SO_4 per liter : 49.03
Gms. Br_2 per liter : 29.26

DISTRIBUTION OF BROMINE BETWEEN GLACIAL ACETIC ACID AND AIR
(Dancaster, 1932)

t°	Gm. Mols. Br_2 per liter			t°	Gm. Mols. Br_2 per liter		
	CH_3COOH layer(L)	Air layer(A)	$\frac{L}{A}$		CH_3COOH layer(L)	Air layer(A)	$\frac{L}{A}$
15	0.04712	0.00005945	792.6	25	0.89242	0.001707	522.8
"	0.59393	0.0007480	794.0	30	0.04017	0.00009589	418.9
20	0.04605	0.00007210	638.7	"	0.29630	0.0007056	419.9
"	0.58243	0.0009129	638.0	40	0.04696	0.0001706	275.3
25	0.04272	0.00008228	519.2	"	0.39274	0.001422	276.2

Results are also given for the distribution of bromine between air and glacial acetic acid solutions of CH_3COONa , CH_3COOK and Na_2HPO_4 which do not form per-halides and for $LiCl$, $NaCl$, KCl and $AlCl_3$, which normally form the tri halide and $HgCl_2$, $FeCl_3$, $SnCl_4$ and $SbCl_3$ which give higher values than the normal halides. Results are also given for glacial acetic acid solutions of KBr which forms principally the penta- instead of the tri halide as in the case of the normal chloride salts.

SOLUBILITY OF BROMINE IN AQUEOUS ACETIC ACID SOLUTIONS

The coefficient of solubility of bromine in water at 15°, determined by an aspiration method, is given as 33 by Jones (1911). This investigator also gives the figure 56 for the solubility coefficient in 25 vol. % acetic acid and 551 for 90 vol. % acetic acid at 15°. ["coefficient of solubility" = ml of Br_2 gms. (S.T.P.) dissolved in one ml of solvent when the partial pressure of the bromine is one atmosphere]

THE SYSTEM $Br_2 + KBr + H_2O$

Results at 0°

(Harris, 1932; Zernike, Nawab, and Aziz, 1951)

The solubility data are in good agreement but the composition of the bromine hydrate was found to be $Br_2 \cdot 10H_2O$ by Harris and $Br_2 \cdot 7H_2O$ by Z., N. and A. Most of the investigations to date place the composition at about 7-8 moles of water. The data of these two authors are nearly identical. Those below are from Harris. A few points of Z. N. and A. are given in parenthesis for comparison.

Br BROMINE

THE SYSTEM $\text{Br}_2 + \text{KBr} + \text{H}_2\text{O}$ AT 0° --(Cont.)Results at 0° --Cont.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Br_2	KBr	Solid Phase	Br_2	KBr	Solid Phase
2.31	0.0	$\text{Br}_2 \cdot 10\text{H}_2\text{O}$	53.84	17.13	2 liquid layers
(4.75)	(8.96)	$(\text{Br}_2 \cdot 7\text{H}_2\text{O})$	61.60	16.77	" "
9.73	5.39	$\text{Br}_2 \cdot 10\text{H}_2\text{O}$	68.87	15.54	" "
12.15	6.85	"	76.26	13.81	" + $2\text{KBr}_6 \cdot 3\text{H}_2\text{O}$
13.22	7.25	"	(76.42)	(13.92)	" + "
14.54	8.20	"	75.28	13.85	$2\text{KBr}_6 \cdot 3\text{H}_2\text{O}$
(21.84)	11.29	$(\text{Br}_2 \cdot 7\text{H}_2\text{O})$	71.06	16.25	"
24.77	12.33	$(\text{Br}_2 \cdot 10\text{H}_2\text{O})$	67.61	18.18	"
26.71	13.07	"	(61.80)	(21.27)	"
32.76	14.70	"	58.51	22.87	"
34.12	14.79	" + 2 liquid layers	54.87	26.01	"
(35.48)	(15.01)	$(\text{Br}_2 \cdot 7\text{H}_2\text{O} + 2 \text{ " "})$	52.85	29.02	" + KBr
35.36	15.09	2 liquid layers	(52.90)	(29.65)	" + "
41.95	16.14	" "	50.30	29.50	KBr
			34.46	31.54	"

SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE
(Results at 0° and 25° , Boericke, 1905; at 0° , Jones and Hartmann, 1916;
at 18.5° and 26.5° , Worley, 1905)

KBr		+ Gms. Bromine Dissolved per Liter of Sat. Solution at:			
mols. per liter	Gms. per liter	0° *	18.5°	25°	26.5°
0	0	41.6 (24.2)	35.56	34	34.23
0.005	0.59	41.7 (25.5)	36.1	34.3	35.1
0.010	1.19	42.6 (26.2)	37	35	36
0.020	2.38	44.4 (27.5)	38.56	36.5	37.35
0.050	5.95	50.2 (31.5)	43.8	41	42.5
0.100	11.90	59.7 (40)	52.23	49.3	51.87
0.20	23.80	79.1 (57.1)	69.69	67.3	68.69
0.50	59.51	138.6 (111.9)	123	119	116
0.80	92.22	200 (174)	178.70	176	168.10
1.00	119.02	243.1 (217.5)	216	216.5	204
1.725	205.2	402.3 (395.9)	....	....	....
1.82	216.6	423.8 (423)	....	....	....
2.17	258.2	511.7 (511.7)	....	....	....
3.033	360.8	736.7 .....	....	632.4	....

*Very accurate determinations at 0° , at concentrations of KBr below 0.01 normal, are given by Jones and Hartmann. Liquid bromine in contact with aqueous solutions at 0° is slowly converted to the hydrate, $\text{Br}_2 \cdot 10\text{H}_2\text{O}$, with a reduction in amount of dissolved bromine. At this temperature there are, consequently, two saturation concentrations. The unstable one being for solutions in contact with liquid bromine and the stable one being for solutions in contact with $\text{Br}_2 \cdot 10\text{H}_2\text{O}$. The results for the latter are shown in parentheses in the above table.

(Cont.)

SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE--Cont.

At 25°, Jones and Baekstrom, 1934 give results for the solubility of Bromine in aqueous KBr solutions of 0.01 to 0.10 normality. The equilibrium constant of the reaction $\text{Br}_2 + \text{Br}^- \rightleftharpoons \text{Br}_3^-$ was found to be 16.0 and that for the reaction $2\text{Br}_2 + \text{Br}^- \rightleftharpoons \text{Br}_3^-$ was calculated to be 40.0. Determinations are also given of the hydrolysis constant of bromine in water and the activity coefficient of bromine in aqueous solutions of KNO_3 .

Isobars for the partial pressure of Br_2 in the system $\text{Br}_2 - \text{KBr} - \text{H}_2\text{O}$ at 20° are given by Lushinski (1939). There are no azeotropes in the system.

SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF SODIUM BROMIDE AT 25°
(Bell and Buckley, 1912)

Grams per Liter Sat. Sol.		d_{25} of Sat. Sol.	Gms. per Liter Sat. Sol.		d_{25} of Sat. Sol.
NaBr	Br_2		NaBr	Br_2	
92.6	99.2	1.213	319.7	546	1.997
160.5	176.7	1.372	359	641.6	2.137
205.8	247.8	1.515	...	769.2	2.327
255.8	343	1.678	408.3	834	2.420

*
THE SYSTEM $\text{Br}_2 + \text{CsBr} + \text{H}_2\text{O}$
(Harris, 1932)

Results at 0°			Results at 25°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Br_2	CsBr		Br_2	CsBr	
4.25	2.73	$\text{Br}_2 \cdot 10\text{H}_2\text{O}$	3.48	0.0	Liquid Br present
5.72	4.46	" + CsBr	11.70	13.53	Two liquids
4.80	5.07	CsBr_3	12.13	14.56	Solid + two liquids
2.97	6.55	"	59.20	34.77	" " "
1.12	20.80	"	4.26	20.14	CsBr_3
0.81	43.35	" + CsBr	2.15	55.51	" + CsBr
...	45.00	"	...	55.23	CsBr
86.20	13.80	CsBr_3	64.42	32.08	CsBr_3
77.43	20.75	"	81.06	18.94	—
73.70	23.54	" + $\text{Br}_2 \cdot 10\text{H}_2\text{O}$	16.35	18.90	Invariant at 30.6°
78.91	19.14	$\text{Br}_2 \cdot 10\text{H}_2\text{O}$			
85.61	13.18	"			
92.63	6.71	"			

Br BROMINE

THE SYSTEM $\text{Br}_2 + \text{HgBr}_2 + \text{H}_2\text{O}$ AT 25°
(Herz and Paul, 1914)

Gms. per 100 cc. Sat. Sol.		Saturating Phase	Gms. per 100 cc. Sat. Sol.		Saturating Phase
HgBr ₂	Br		HgBr ₂	Br	
0	3.40	Br ₂	0.763	3.57	Br ₂ + HgBr ₂
0.202	3.53	"	0.701	2.88	HgBr ₂
0.285	3.55	"	0.664	1.20	"
0.462	3.56	"			

SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF STRONTIUM BROMIDE AT 25°
(Pearce and O'Leary, 1923)

Mols. per 1000 gms. H ₂ O		Mols. per 1000 gms. H ₂ O		Mols. per 1000 gms. H ₂ O	
SrBr ₂	Br ₂	SrBr ₂	Br ₂	SrBr ₂	Br ₂
0.000	0.21966	0.06183	0.34871	0.25015	0.87806
0.01229	0.23862	0.12361	0.47838	0.30555	1.09510
0.02455	0.26533	0.19916	0.73592	0.39113	1.25960
0.05683	0.31524	0.22293	0.80442		

SOLUBILITY OF BROMINE IN VARIOUS AQUEOUS SALT SOLUTIONS AT 25°
(Jakowkin, 1906; McLauchlan, 1903; Oliveri-Mandala, 1920)

Salt	Gms. per liter		Salt	Gms. per liter	
	Salt	Br		Salt	Br
K ₂ SO ₄	91.18	24.8	KNO ₃	101.19	28.95
	91.18	25.14		85.09	28.0
	45.59	29.44		85.09	28.80
	22.79	31.46		42.54	31.35
	11.39	32.70		21.27	32.62
Na ₂ SO ₄	5.69	33.10	NH ₄ Cl	10.63	33.33
	63.55	23.9		5.31	33.74
	63.55	25.07		53.52	82.2
	31.77	29.20		74.60	57.40
	15.88	31.33		at 20.6°	
(NH ₄) ₂ SO ₄	7.94	32.94	NaCl	40.8	51.3
	3.97	33.26		63.6	61.7
	70.04	77.7		81.0	67.8
	NH ₄ C ₂ H ₃ O ₂	340.5		103.3	78.7
	NH ₄ NO ₃	55.15		118.4	86.4
				135.1	97.8
				at 25°	
				58.5	55.9

EQUILIBRIUM IN THE SYSTEM BROMINE - TETRAMETHYLAMMONIUM BROMIDE -
WATER AT 25°

(Bloch, Farkas, Schnerb, and Winogron, 1949)

Gms. per liter		Condensed Phases
$(\text{CH}_3)_4\text{NBr}$	Br_2	
562.5	0.0	$(\text{CH}_3)_4\text{NBr}(s)$
562.5	5.75	$(\text{CH}_3)_4\text{NBr}(s) + 1:2 (s)$ orange
*300	4.8	1:2 (s) orange
142.0	4.5	"
*90.0	5.05	"
50.2	6.65	1:2 (s) orange + 1:2 (s) red
40.0	7.0	1:1 (s) red + 1:4.2 (L)
17.3	5.95	1:5.15 (L) + 1:8 (S)
6.6	5.15	1:8 (s)
*1.2	7.7	"
0.28	25.3	"
0.15	32.0	$\text{Br}_2 (L)$ (99% by wt.)

*Read from the curves given by the authors.

(s) = solid (L) = liquid

1:2 = $(\text{CH}_2)_4\text{NBr} \cdot \text{Br}_2$ 1:4.2 Liquid composition $(\text{CH}_3)_4\text{NBr} \cdot \text{Br}_{4.2}$ 1:8 = $(\text{CH}_3)_4\text{NBr} \cdot \text{Br}_8$ 1:5.15 " " $(\text{CH}_3)_4\text{NBr} \cdot \text{Br}_{5.15}$ DISTRIBUTION OF BROMINE BETWEEN IMMISCIBLE LIQUIDS
Water and Carbon Tetrachloride

Results at 0°

(Jones and Hartmann, 1916)

Gm. Br_2 per gm. CCl_4 solution	Density $\text{CCl}_4 \cdot \text{Br}_2$	Mols. Br_2 per liter	
		in CCl_4	in H_2O
0.1646	1.7667	1.8194	0.07015
0.08661	1.7012	0.9218	0.03937
0.08162	1.6972	0.8666	0.03771
0.07261	1.6896	0.7676	0.03344
0.06126	1.6809	0.6442	0.02870
0.05433	1.6755	0.5695	0.02572
0.01847	1.6470	0.1903	0.00901
0.01640	1.6454	0.1687	0.008007

Results at 25°

(Pearce and O'Leary, 1923)

Mols. Br_2 per 1000 gms.			Mols. Br_2 per 1000 gms.		
H_2O of the H_2O layer(W)	CCl_4 of the CCl_4 layer(C)	$\frac{C}{W}$	H_2O of the H_2O layer(W)	CCl_4 of the CCl_4 layer(C)	$\frac{C}{W}$
0.01529	0.28224	18.46	0.06600	1.6553	25.08
0.02984	0.58550	19.62	0.06805	1.7714	26.03
0.03561	0.76320	21.43	0.08648	2.3842	27.57
0.04163	0.89829	21.58	0.08475	2.4207	28.56
0.04613	0.0152	22.01	0.08779	2.5854	29.45
0.04889	1.0686	22.88	0.09249	2.7498	29.73

(Cont.)

DISTRIBUTION OF BROMINE BETWEEN IMMISCIBLE LIQUIDS--Cont.

Water and Carbon Tetrachloride--Cont.

Results at 16.5°
(Griffith, McKeown and Winn, 1932)

Approximate Data of Herz
and Kurzer, 1910 at higher
concentrations (25°)

Mols. Br ₂ per liter			moles per liter	
Aq. layer(W)	CCl ₄ layer(C)	$\frac{C}{W}$	aq. layer	CCl ₄ layer
0.000698	0.01653	33.7	0.10	2.75
0.000985	0.02360	24.0	0.125	3.75
0.001490	0.03755	25.2	0.15	5.00
0.002939	0.0748	25.5	0.175	6.8
0.004950	0.1272	25.8		
0.00700	0.1843	26.3*		

*Contained 0.001 n H₂SO₄

For further data at 15°, 20°, 30° and 40° see Dancaaster, 1932.

Aqueous Acids and Carbon Tetrachloride
HCl

Lewis and Storch (1917) used 0.001 n HCl which prevents the hydrolysis but is presumably too dilute to affect the true solubility. The distribution coefficient found in this way, given in terms of mols. Br per 1000 gms. H₂O, divided by the mol. fraction of Br in the CCl₄, is 0.3705 at 25°.

DISTRIBUTION OF BROMINE BETWEEN AQUEOUS SOLUTIONS OF HYDROCHLORIC
ACID AND CARBON TETRACHLORIDE AT 30°
(Ray and Sarkar, 1922)

Normality of the aq. HCl	Concentration of Bromine in		Normality of the aq. HCl	Concentration of Bromine in	
	Aq. layer	CCl ₄ layer		Aq. layer	CCl ₄ layer
0.25	1.584	36.36	1.0	1.291	16.92
0.25	2.246	51.87	1.0	1.541	19.46
0.5	0.6852	12.69	1.0	1.881	24.00
0.5	0.9210	16.48	1.0	2.989	38.38
0.5	2.1520	38.54			

HBr

Lewis and Storch (1917) give a series of determinations of the distribution of bromine between 0.1 n HBr and CCl₄ at 25°. Results are also given by Sherrill and Izard (1928), Wilks and Martin (1927), and Griffith, McKeown and Winn, 1932.

DISTRIBUTION OF BROMINE BETWEEN IMMISCIBLE LIQUIDS--Cont.

Aqueous acids and CCl_4 

(Griffith, McKeown and Winn, 1932)

Aqueous layer 0.001 normal H_2SO_4

t°	Mols. Br ₂ per liter		$\frac{C}{W}$
	Aq. layer(W)	CCl_4 layer(C)	
16.5	0.0.00700	0.1843	26.3
21.5	0.00646	0.1775	27.5
"	0.00682	0.1881	27.6
"	0.01328	0.370	27.8

Aqueous Salts and Carbon Tetrachloride

Immiscible Solvents	t°	Authority
Aqueous $\text{CdBr}_2 + \text{CCl}_4$	25	(Van Name and Brown, 1917)
Aqueous $\text{CdBr}_2 \cdot 2\text{KBr} + \text{CCl}_4$	25	(" ")
Aqueous $\text{HgBr}_2 + \text{CCl}_4$	25	(Herz and Paul, 1914; Van Name and Brown, 1917)
Aqueous $\text{HgBr}_2 \cdot 2\text{KBr} + \text{CCl}_4$	25	(Van Name and Brown, 1917)
Aqueous $\text{KBr} + \text{CCl}_4$	0-25	(Jones and Hartmann, 1916; Griffith, McKeown and Winn, 1932; Wilke and Martin, 1927)
Aqueous $\text{LiBr} + \text{CCl}_4$	16-25	(Griffith, McKeown, and Winn, 1932)
Aqueous $\text{NaBr} + \text{CCl}_4$	16-25	(" " ")
Aqueous $\text{SrBr}_2 + \text{CCl}_4$	25	(Pearce and O'Leary, 1923)

Distribution Between Water and Other Organic Liquids

Water and Carbon Disulfide at 25°

(Jakowin, 1895)

(Herz and Kurzer, 1910 (in parentheses))

Gms. Bromine per liter		Gms. Bromine per liter	
Aq. Layer	CS_2 Layer	Aq. Layer	CS_2 Layer
0.5	36 (35)	4	330 (310)
1	80 (75)	5	420 (395)
2	163 (155)	6	515 (480)
3	240 (230)	7	620 (565)

Water and Bromoform at 25°

(Jakowin, 1895)

Gms. Bromine per liter		Gms. Bromine per liter	
Aq. Layer	CHBr_3 Layer	Aq. Layer	CHBr_3 Layer
0.5	33	4	276
1	66	5	346
2	136	6	415
3	206	...	...

DISTRIBUTION OF BROMINE BETWEEN IMMISCIBLE LIQUIDS--Cont.

Water and Other Organic Liquids--Cont.

Water and Benzene

Data are given by Lichaejova and Lucinskii (1938) for water and for aqueous KBr solutions.

Water and Tetrachlorethane at 25° (Herz and Rathmann, 1913)		Water and Pentachlorethane at 25° (Herz and Rathmann, 1913)	
Grams Bromine per Liter		Gms. Bromine per Liter	
Aq. Layer	C ₂ H ₂ Cl ₄ Layer	Aq. Layer	C ₂ H ₂ Cl ₅ Layer
0.216	6.47	0.402	10.70
0.592	18.20	0.670	18.29
0.944	29.46	0.864	23.49
1.348	41.65	1.300	35.46
2.444	74.57	2.408	67.44

Distribution Between Water and Mixtures of Carbon Disulfide
and Carbon Tetrachloride at 25°
(Herz and Kurzer, 1910)

25 Vol. % CS ₂ + 75 Vol. % CCl ₄		50 Vol. % CS ₂ + 50 Vol. % CCl ₄		75 Vol. % CS ₂ + 25 Vol. % CCl ₄	
Gms. Bromine per Liter		Gms. Bromine per Liter		Gms. Bromine per Liter	
Aq. Layer	CS ₂ + CCl ₄ Layer	Aq. Layer	CS ₂ + CCl ₄ Layer	Aq. Layer	CS ₂ + CCl ₄ Layer
0.79	28.4	0.63	28.7	0.71	46
1.53	58.4	1.19	54.5	1.34	87.2
2.32	86.6	1.76	81.1	3.98	213.8
2.98	111.3	2.45	110.9	5.06	330.5
3.66	137.8	2.95	132.9	6.82	444.2
5.26	205.1	6.47	343.8		
7.95	324.9	7.97	447.7		
9.66	432.2				

ANHYDROUS BINARY SYSTEMS INVOLVING BROMINE

Bromine + Chlorine
(Lebeau, 1906; see
also Karsten, 1907)

t° of Melting	Gms. Br Per 100 Gms. Mixture
-102.5	0
-100	6.5
-90	31
-80	48.6
-70	60.4
-60	70
-50	79
-40	86.3
-30	91.1
-20	95.2
-10	89
-8.3	96.6*
-7.3	100

*Wulff, 1947

Bromine + Hydrobromic Acid
(Buchner and Karsten,
1908-09)

t° of Melting	Gms. Br per 100 Gms. Mixture	Mol. % Br. in Mixture
-87.3	0	0
-90	6	2.5
-95Eutec.	11.2	4.8
-90	11.8	5
-80	15.2	6.8
-70	22	11.5
-60	31.7	19
-50	43	30
-40	54.5	43.5
-30	66.2	60
-20	79.5	76.5
-12.5	90	90

Bromine + Sulfur
Dioxide
(van der Goot, 1913)

t° of Melting	Gms. Br per 100 Gms. Mixture
-75.1	0
-75.3Eutec.	1.73
-60	4
-40	12.5
-30	21
-20	35.5
-18	40.5
-16	48
-14	72
-13	90
-10	96.5
-7.1	100

Bromine + Chloroform

(Saneshima and Hiramatsu, 1934; Wheat II and Browne, 1936)

The results were plotted on cross section paper and the following average values read from the curves. The lower figures in parentheses are by Sameshima and Hiramatsu.

t°	Mols. Br ₂ per 100 mols. Br ₂ + CHCl ₃	Solid Phase	t°	Mols. Br ₂ per 100 mols. Br + CHCl ₃	Solid Phase
-63.5(m.pt.)	0	CHCl ₃	-50	36.0(24.0)	Br ₂
-65	3.0	"	-45	42.5(29.0)	"
-67.5	6.7	"	-40	49.5(34.5)	"
-70.0	10.0	"	-35	56.0(41.0)	"
-71.5(Eutec.)	12.5	" + Br ₂	-30	63.5(48.5)	"
-70	14.0(13.0)	Br ₂	-25	70.5(58.0)	"
-65	19.0(15.0)	"	-20	78.0(69.0)	"
-60	24.0(17.0)	"	-15	85.5(80.5)	"
-55	30.0(20.0)	"	-10	94.0(93.0)	"
			-7.3	100.0(100)	"

Bromine + Carbon Tetrachloride

(Sameshima and Hiramatsu, 1934)

t°	Mols. Br ₂ per 100 mols. Br ₂ + CCl ₄	Solid Phase	t°	Mols. Br ₂ per 100 mols. Br ₂ + CCl ₄	Solid Phase
-22.9	0.0	CCl ₄	-38.5	32.08	Br ₂
-30.0	4.8	"	-32.1	40.60	"
-36.4	8.68	"	-25.0	55.32	"
-42.0	10.99	"	-20.0	67.49	"
-47.5	15.10	"	-15.2	79.78	"
-47.6	17.26	Br ₂	-10.0	92.20	"
-46.7	20.00	"	7.3	100.00	"

Br BROMINE

Bromine + Phosphorus Trichloride
(Fialkov and Kuzmenko, 1951)

t°	mole % PCl ₃	Solid Phase	t°	mole % PCl ₃	Solid Phase
-7.0	0	Br ₂	17.5	22.78	PCl ₃ .Br ₄
-8.4	5.48	Br ₂ + PCl ₃ .Br ₁₈	18.7	23.04	"
9.0	8.14	PCl ₃ .Br ₁₈	20.0	23.61	"
17.0	9.13	"	23.5	24.38	"
23.4	9.54	"	26.2	25.60	"
24.5	10.04	"	34.5	28.62	"
23.6	10.84	"	36.5	31.70	"
23.0	13.48	"	37.3	34.81	"
23.5	16.82	"	37.3	38.90	"
18.58	22.2	"	36.9	49.24	"
19.72	18.5	"	36.6	61.78	"
16.2	20.21	"	36.8	76.48	"
15.5	20.72	" + PCl ₃ .Br ₄	-112.5	100.0	PCl ₃

Bromine + Bromine Trifluoride
(Fischer, Steunenber and Vogel, 1953)

t°	mole% bromine	Solid	Two-Liquid Region mole% bromine		
			t°	Upper	Lower
8.7	0.0	A	9.0	13.9	95.4
7.4	2.58	A	16.1	16.2	94.8
6.2	5.36	A	25.0	17.7	92.9
4.9	9.80	A	31.0	20.6	91.1
-3.7	97.65	A	35.3	22.2	90.0
-8.0	99.20	B	45.8	29.7	84.8
100	-7.2	B	49.1	33.6	82.3
			50.8	..	80.0
			53.9	46.8	..
			55.5	Approx. 61	(consolute)

A = BrF₃B = Br₂

Bromine + Carbon
Disulfide
(Arctowsti, 1895-1896)
Solutions saturated
with bromine
Gms. Bromine
per 100 Gms.
sat. sol.

t°	
-95	45.4
-110.6	39.0
-116	36.9

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD
ARE ALSO GIVEN FOR THE FOLLOWING MIXTURES:

Bromine + Methyl alcohol (Maass and McIntosh, 1912)
" + Ethyl alcohol (" ")
" + Ethyl ether (McIntosh, 1911)
" + Ethyl acetate (Maass and McIntosh, 1912)
" + Acetone (" ")
" + Ethyl bromide (Wroczynski and Guye, 1910)
" + Iodine (Meerum-Terwogt, 1905; Kruyt and Heldermann, 1918)
" + Sulfur (Ruff and Winterfeld, 1903)
" + Ethylene oxide (Maass and Boomer, 1922)
" + Carbon tetrabromide (Biltz and Meinecke, 1923)
" + Nitric oxide (Trautz and Dalai, 1920)
" + Tellurium (Damiens, 1921a; 1923)
" + Titanium tetrachloride (Lutshinsky, 1935)
" + Pyridinium bromide (Lombard and Heywang, 1952)
" + Tetramethyl ammonium bromide (Bloch, Farkas, Schnerb, and Winogren, 1949)

THE SYSTEM BROMINE - IODINE - CHLORINE AT 29.8°
(Campbell and Shemilt, 1946)

The authors found two compounds in the system: IBr and ICl₃, but there is no solution in the system which is saturated with two solid phases. Iodine forms a continuous series of solid solutions with IBr which may contain up to 4% chlorine [some difficulty was encountered in separating the solids from the solution, and also in the determination of small amounts of chlorine]. Results are given for solutions containing less chlorine than the compound ICl₃, which could be handled in open vessels. Analyses were made by reducing the halogens with zinc and titrating potentiometrically with silver nitrate solution. The estimated accuracy was about 1%.

Solution		Wet Solid Phase		Solid Present
Wt. % Br	Wt. % I	Wt. % Br	Wt. % I	
48.55	51.45	43.41	56.59	IBr
46.85	50.24	42.66	55.34	Solid Solution IBr + I + Cl
46.01	50.79	42.12	55.40	"
44.56	51.52	41.71	56.20	"
34.73	59.24	35.37	61.20	"
29.27	63.80	31.07	64.70	"
26.50	66.11	28.65	66.35	"
19.77	71.80	21.06	72.43	"
15.44	74.42	16.65	76.00	"
11.29	77.76	12.94	81.00	"
7.67	81.23	6.99	87.45	"
4.49	83.07	3.81	89.59	"
...	84.72	...	93.23	Iodine
...	72.60	...	65.30	ICl ₃
4.04	69.91	2.58	62.92	"
11.89	64.63	6.27	60.32	"
14.96	61.94	7.29	55.58	"
16.34	60.11	8.11	56.03	"
20.72	56.35	12.22	54.45	"
40.80	36.98	18.87	58.43	"
42.71	35.18	13.50	48.93	"
61.52	22.52	32.82	36.13	"

SOLUBILITY OF BROMINE IN GRAPHITE

Graphite will absorb 84% of its own weight of bromine when placed in an atmosphere of bromine at room temperature. This corresponds to an atomic ratio of 1Br:8C. X-ray analysis shows a solution of bromine in the graphite lattice, rather than any definite compound formation, and the bromine is given off if the product is exposed to air (Rudorff, 1941). Results in agreement with these were obtained by Herold, 1954 who found the compositions 1Br:8C' and 1Br:10C were produced by heating graphite and exposing it to a constant pressure of bromine.

C CARBON

CARBON C

The solubilities of organic (carbon) compounds are given in a separate volume. Data are CBr_4 , CCl_4 , CS_2 , COCl_2 etc. will be found there; only the oxides and nitrides are listed in this volume.

N CYANOGEN $(\text{CN})_2$

SOLUBILITY IN WATER

(Gay Lussac, 1815, Berthelot, 1904; Naumann, 1910)

Berthelot's determinations were made over mercury with exclusion of air. The mercury was not attacked by the $(\text{CN})_2$. On account of polymerization, the solubility increased with time of contact and amount of agitation of the mixture.

Naumann shows a curve for the weight of cyanogen dissolved in 100 gms. of water solution as a function of time. The curve seems to approach a limit of about 0.4 gms. per 100 gms. of solution, but the author states that other determinations at longer time intervals (up to two hours) gave the higher values listed below.

t°	Time	Gms. $(\text{CN})_2$ per 100 gms. H_2O	Author
30°	2 hrs.	0.73 (3.5 cc/cc H_2O)	(Berthelot)
30°	97 hrs.	2.03 (9.7 cc/cc H_2O)	(")
25°	2 hrs.	1.1 - 1.3	(Naumann)
Room	?	0.98	(Gay Lussac)

SOLUBILITY IN OTHER SOLVENTS AND SOLUTIONS AT 20° (Berthelot, 1910)

Solvent	time hrs.	cc. $(\text{CN})_2$ per cc. solvent	Solvent	time hrs.	cc. $(\text{CN})_2$ per cc. solvent
$\text{C}_2\text{H}_5\text{OH}$	~ 0	26	CHCl_3	~ 0	19
	4	39		?	29-30
	48	89	Benzine	$\infty(?)$	28
	96	223	Turpentine	?	9-10
CH_3COOH	~ 0	42	Ether	?	5*
	72	50.5	0.01 n HCl	?	> 0.9 gms./100 gms. soln.†

*Gay Lussac, 1815

†Naumann, 1910

CYANAMIDE $\text{CN}\cdot\text{NH}_2$

N

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD
(Pratolongo, 1914)

t° of Congealing	Gms. $\text{CN}\cdot\text{NH}_2$ per 100 Gms.		Solid Phase	t° of Congealing	Gms. $\text{CN}\cdot\text{NH}_2$ per 100 Gms.		Solid Phase
	Sat.	Sol.			Sat.	Sol.	
-0.62	2.58	-	Ice	-14.39	40.19		$\text{CN}\cdot\text{NH}_2$
-3.96	9.42		"	-2.49	56.80		"
-7.58	18.40		"	+14.50	77.20		"
-12.72	30.9		"	25.6	87.15		"
-16.6 Eutec.	37.8		" + $\text{CN}\cdot\text{NH}_2$	37.90	96.77		"
-15.6	38.75		$\text{CN}\cdot\text{NH}_2$	42.0	100		"

Freezing point data for the systems CNNH_2 + Urea and CNNH_2 + dicyandiamide are given by Pratolongo, 1914.

DICYANDIAMIDINE Perchlorate $\text{C}_2\text{H}_8\text{N}_4\text{OHCIO}_4$

100 gms. H_2O dissolve 9.07 gms. of the salt at 17° (d sat. sol. = 1.039). (Carlson, 1910).

CARBON MONOXIDE CO

O

SOLUBILITY IN WATER .

The data below are determined by Winkler, 1901. In the following table are some results which do not agree too well with these. See also O'Brien and Parker, 1922. There is no very recent work.

β = Vol. of CO (measured at 0°, 760mm) absorbed by 1 volume of liquid at a partial pressure of CO of 760mm.

β' = Vol. of CO (measured at 0°, 760mm) absorbed by 1 volume of liquid at a total pressure (CO + vapor) of 760mm.

q = Grams of CO dissolved by 100 gms. H_2O at a total pressure of 760mm.

t°	β , "Absorp. Coef."	β' , "Solu- bility."	q	t°	β , "Absorp. Coef."	β' , "Solu- bility."	q
0	0.03537	0.03516	0.0044	40	0.01775	0.01647	0.0021
5	0.03149	0.03122	0.0039	50	0.01615	0.01420	0.0018
10	0.02816	0.02782	0.0035	60	0.01488	0.01196	0.0015
15	0.02543	0.02501	0.0031	70	0.01440	0.00998	0.0013
20	0.02319	0.02266	0.0028	80	0.01430	0.00762	0.0010
25	0.02142	0.02076	0.0026	90	0.01420	0.00438	0.0006
30	0.01998	0.01915	0.0024	100	0.01410	0.00000	0.0000

SOLUBILITY OF CARBON MONOXIDE IN WATER--Cont.

Other Data:

(Bunsen, 1877 recalculated by Henrich, 1892; Labarsch, 1889; Just, 1901; Skirrow, 1902; Findlay and Creighton, 1911; Christoff, 1906).

t°	β	t°	β	t°	β
0	0.03278 (B-H)	15	0.02434 (B-H)	25	0.02258 (B-H)
5	0.02908 (B-H)	20	0.02311 (B-H)	25	0.02282 (J.)
10	0.02636 (B-H)	20	0.0230 (L)	25	0.01417 (F.C.)
		20	0.0241 (S)	25	0.02273(C)

SOLUBILITY OF CARBON MONOXIDE IN WATER AT HIGHER PRESSURES
(Cassuto, 1904)

The results were interpolated from the author's data. The values of S are from the equation $l = SP$ where l is the Ostwald solubility coefficient, and P is the total pressure in meters. Data are also given by Cassuto, 1913.

Total Pressure in Meters	S		Total Pressure in Meters	S	
	17.7°	19°		17.7°	19°
1.000	0.02789	0.02716	5.000	0.02761	0.02675
2.000	.02783	.02710	6.000	.02754	.02665
3.000	.02773	.02696	7.000	.02739	.02643
4.000	.02770	.02688	8.000	.02715	.02614

SOLUBILITY OF CARBON MONOXIDE SOLUTIONS OF ELECTROLYTES

l = volumes of CO (measured at 760mm and the temp. of the experiment) absorbed by 1 volume of liquid at a partial pressure of 760mm. (Ostwald coefficient).

Results in H_2SO_4 at 25° (Christoff, 1906)		Result in "Acid Sulfate" solution at 25° (See Note p. 251) (Kobe and Kenton, 1938)	
% H_2SO_4	l		
0.0	0.02482		$l = 0.0039$
35.82	0.0114		
61.62	0.00958		
95.6	0.0216-0.0233		

IN NaOH SOLUTIONS:

Data for the solubility of CO in aq. NaOH solutions are given by Fonda, 1910.

SOLUBILITY OF CARBON MONOXIDE IN CUPROUS SOLUTIONS

The solubility of carbon monoxide in solutions of cuprous ammonium carbonate and of cuprous ammonium formate has been studied by Hainsworth and Titus (1921) and by Larson and Teitsworth (1922). Results are given for solutions containing from 35 gm. to 125 gms. Cu^+ per liter, at temperatures from 0° to 60° , and at partial pressures of carbon monoxide from 0 cm to 260 cm of Hg. The solubility is proportional to the amount of Cu^+ in solution. With increasing pressure, the amount of carbon monoxide absorbed approaches a maximum which corresponds to 1 mol. of CO per mol. of Cu^+ in solution. The solutions decompose to a slight extent, precipitating metallic copper.

SOLUBILITY OF CARBON MONOXIDE IN ALCOHOLS
(Gjaldbak, 1948)

The following results were interpolated by the author from his experimental data, and are expressed as ml of CO (measured at 760 mm and the temperature of the experiment) dissolved in 1 ml of solvent (t).

Solvent	t			
	20°	25° *	35°	50°
CH_3OH^a	0.224(.1830)*	.1955*	0.230	0.248
$\text{C}_2\text{H}_5\text{OH}^b$	.200(.1901)*	.1921*	.207	.216
n - $\text{C}_3\text{H}_7\text{OH}$	.177	....	.182	.189
i - $\text{C}_3\text{H}_7\text{OH}$	.190	....	.196	.206
n - $\text{C}_4\text{H}_9\text{OH}$	.164	....	.169	.173
i - $\text{C}_4\text{H}_9\text{OH}$	.174	....	.180	.186
n - $\text{C}_5\text{H}_{11}\text{OH}$	.1706*	.1714*	...	...
Cyclohexanol	....	.887 (26°)

* (Just, 1901; Skirrow, 1902).

^aResults from 25° - 140° up to 300 atm are given by Krichevskii, Zhavoronkov and Tsiklis, 1937.

^bCarius (1855) found the value $0.204 \pm .001$ cc (S.T.P.) from 2° - 24° .

SOLUBILITY OF CARBON MONOXIDE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS
AT 20° AND 760 MM. PRESSURE
(Lubarsch, 1889)

Wt. % Alcohol	Vol. % Absorbed CO	Wt. % Alcohol	Vol. % Absorbed CO
0	2.41	28.57	1.50
9.09	1.87	33.33	1.94
16.67	1.75	50	3.20
23.08	1.68		

C CARBON

SOLUBILITY OF CARBON MONOXIDE IN VARIOUS ORGANIC SOLVENTS
(See p. 455 for alcohols)

l = ml. CO measured at 760mm and t° C absorbed by 1 ml. of solvent when the partial pressure of CO is 760mm.

- | | |
|---------------------|----------------------------------|
| (1) Just, 1901 | (5) Gniewosz and Walfisz, 1887 |
| (2) Christoff, 1912 | (6) Peter and Weinert, 1955 |
| (3) Horiuti, 1931 | (7) Skirrow, 1902 |
| [with great care!] | (8) E.I. Dupont, 1955 |
| (4) Gjaldbaek, 1952 | (9) Gjaldbaek and Anderson, 1954 |

0

Solvent	t°	l	Author	Solvent	t°	l	Author	
Aniline	20	0.05055	(1)	Chloroform	20	0.1897	} (1)	
	25	0.05358				25		0.1954
	25	0.0506	(9)	1,2-di	25	0.0849	(9)	
Acetic acid	20	0.1689	} (1)	bromethane		0.196-.207	(7)	
	25	0.1714			Dimethyl-	25	0.06	(8)
Acetone	-79.8	0.1917	} (3)	formamide				
	-59.7	0.1961			Ethyl	20	0.2419	} (1)
	-40.3	0.2053			acetate		0.2516	
	-20.5	0.2178			Ethyl	-78.8	0.3820	} (3)
	0.0	0.2336			ether	-59.5	0.3660	
	20.0	0.2538				-40.1	0.3627	
		0.2128	} (1)		-20.1	0.3651		
	25	0.2516				0.0	0.3790	
		0.238	(7)			0.3618	} (2)	
	40	0.2732	(3)		10	0.3842		
Amyl acetate	20	0.2108	} (1)		20.0	0.3907	(3)	
	25	0.2140			n-Heptane	25	0.286	} (4)
Benzene	12	0.1702	} (3)	n-per-	25	0.416		
	20	0.1771			fluoro-			
		0.1645	} (1)	heptane				
	25	0.1707			Isobutyl	20	0.2314	} (1)
		0.174	(2)	acetate	25	0.2365		
		0.184	(4)	Ethyl	25	0.147	(7)	
	40.05	0.1972	} (3)	dichloride				
	60.3	0.2201			Methyl	-78.8	0.1812	} (3)
Benzyl cyanide	25	0.0762	(9)	acetate	-60.4	0.1897		
Carbon disulfide	20	0.08112	(1)		-40.9	0.2023		
	25	0.08314	(1,7)		-20.3	0.2182		
		0.184	(4)		0.0	0.2363	} (3)	
		0.1837			20.0	0.2549		
Carbon tetra-	-19.9	0.1837	} (3)		40.1	0.2761	} (1)	
chloride	0.0	0.1977			Nitro-	20		0.09105
	20.0	0.2142		benzene	25	0.09366	(9)	
	40.1	0.2314	} (3)			0.0887	(6)	
	60.1	0.2528			Paraffin	see p. 457		
Chloro-	-40.45	0.1201	} (3)	Petroleum	10	0.134	} (5)	
benzene	-21.3	0.1273				20		0.123
	0.0	0.1375	} (3)	Propio-	25	0.217	} (9)	
	20.0	0.1483			nitrile			
	40.0	0.1600			n-Propyl	25		0.248
	60.0	0.1735			acetate			
	80.35	0.1898			Pyridine	25		0.117

(Cont.)

SOLUBILITY OF CARBON MONOXIDE IN VARIOUS ORGANIC SOLVENTS--Cont.

(1) Just, 1901

(9) Gjaldbaek and Anderson, 1954

Solvent	t°	Author	Solvent	t°	Author
Toluene	20	0.1742 } (1)	Xylene	20	0.1744 } (1)
	25			25	
		0.1808 } (1)			0.1781 } (1)
		0.187 (9)			

Paraffin: Using crude paraffin of average molecular weight 345 the solubility at higher pressures (1 - 10 Kp/cm²) is:

0.0073 mole CO/Kg. paraffin x Kp/cm ²	at 106°	0
.0087	at 203°	
.0108	at 300°. (Peter and Weinert, 1955).	

SOLUBILITY OF CARBON MONOXIDE IN MIXED ORGANIC SOLVENTS AT 25°
(Skirrow, 1902)

The solubility in these mixtures is generally an additive function.
l = the Ostwald solubility coefficient [ml CO measured at 25°, 1 atm absorbed by 1 ml mixed solvent when the partial pressure of CO is 1 atm.]

Solvent	Solvent Composition Wt. % CH ₃ COOH	<i>l</i>	Solvent	Solvent Composition Wt. % (CH ₃) ₂ CO	<i>l</i>
<u>Acetic Acid</u>			<u>Acetone</u>		
+ Aniline	100	0.173	+ Aniline	100	0.238
"	86.5	0.110	"	79.2	0.179
"	58.3	0.070	"	44.9	0.110
"	17.8	0.058	+ Carbon Disulfide	82	0.236
"	0	0.053	"	50.5	0.227
+ Benzene	67.5	0.199	"	26	0.187
"	33.5	0.198	"	14.5	0.144
"	19.2	0.190	"	0	0.096
"	0	0.174	+ Naphthalene	86.7	0.199
+ Chloroform	56.4	0.196	"	72.6	0.187
"	0	0.206	+ Chloroform	66.6	0.226
+ Nitrobenzene	78.4	0.156	"	26.5	0.212
"	48	0.130	"	0	0.207
"	0	0.093	+ Naphthol	86	0.190
+ Toluene	74.7	0.191	"	73.1	0.169
"	56.9	0.195	+ Nitrobenzene	78.4	0.207
"	20.5	0.190	"	46.8	0.157
"	0	0.182	"	0	0.093
			+ Phenanthrene	87.2	0.205
			"	75	0.183

C CARBON

SOLUBILITY OF CARBON MONOXIDE IN MIXED ORGANIC SOLVENTS AT 25°—Cont.

Solvent	Solvent Composition mole % ethyl dichloride	l
Ethyl dichloride		
+ Carbon disulfide	100	0.147
"	75	0.157
"	51	0.160
"	18.4	0.140
"	0.0	0.083
	Wt. % C ₆ H ₆	l
Benzene		
+ Aniline	87.3	0.156
"	71.7	0.131
"	42.6	0.095
"	21.2	0.068
"	0	0.053
+ Nitrobenzene	71.8	0.152
"	45.1	0.127
"	0	0.093
+ Ethyl Alcohol	47.7	0.181
"	0	0.192
+ Naphthalene	100	0.174
"	88.5	0.164
"	66.2	0.141
+ Phenanthrene	89.5	0.144
"	72.6	0.127
+ α Naphthol	96.5	0.149
"	87.9	0.139
+ β Naphthol	97.9	0.158
"	95.6	0.149

Solvent	Solvent Composition Wt. % C ₆ H ₅ CH ₃	l
Toluene		
+ Aniline	100	0.182
"	93.4	0.169
"	80.1	0.148
"	55.4	0.115
"	25.4	0.077
"	0	0.053
+ Naphthalene	92.9	0.169
"	84.9	0.161
"	77.3	0.153
+ α Naphthol	95.5	0.171
"	91.2	0.162
+ Nitrobenzene	81.7	0.160
"	50.8	0.131
"	23.7	0.108
"	0	0.093
+ Phenanthrene	94.4	0.170
"	88.8	0.161
"	78.4	0.147
	Wt. % CH ₃ OH	l
Methanol		
+ Chloroform	0.0	0.207
"	13.0	0.202
"	100	0.196
+ Glycerine	22.9	0.025
"	29.5	0.052
"	60.4	0.096
"	100.0	0.196

SOLUBILITY OF CARBON MONOXIDE IN RUBBER

100 cc. of Rubber saturated with carbon monoxide at 21°, dissolve 6.2 cc. CO (at 0° and 760 mm.). The determination was made by pumping out the gas with a Töpler pump and measuring it over mercury. Results for the effect of temperature and pressure upon the solubility are also given. (Venable and Fuwa, 1922).

SOLUBILITY OF CARBON MONOXIDE IN PHYSIOLOGICAL SOLUTIONS

SOLUBILITY OF PURE CARBON MONOXIDE IN SERUM AND IN PLASMA
(O'Brien and Parker, 1922)

As a check on the determinations the authors also determined the solubility of carbon monoxide in water and obtained results in good agreement with those of Winkler.

cc. of CO absorbed per 1.0 cc. of

t°	Beef serum	Sheep serum	Human serum	Beef plasma
15	0.203	0.0206	....	0.0198
20	0.181	0.0187	0.0180	0.0181
25	0.161	0.0156	0.0183	0.0169
30	0.145	0.0153	0.0158	0.0147
37	0.129	0.0144	0.0142	0.0134

Data for the solubility of CO in ox blood and ox serum at 25° are given by Findlay and Creighton, 1910-11.

Data for the influence of time on the absorption of CO by blood are given by Grehaut (1894). The author passed air containing from one part CO per 1000 to one part CO per 60,000, through 100 cc. portions of blood and found that the maximum absorption, 18.3 cc. CO per 100 cc. of blood (for the 1 : 1000 mixture) occurred in three hours.

Data for the solubility of CO in aqueous hemoglobin solutions are given by Hufner (1895) and Hufner and Kulz (1895).

CARBON DIOXIDE CO₂

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SOLUBILITY IN WATER

(1) Bohr (1899); Geffcken (1904); Just (1901); (2) Morgan and Payne, 1930; (3) Markham and Kobe, 1941, 1941a; (4) v. Kless, Lajtai and Thury, 1937; (5) Showalter and Ferguson, 1936; (6) Gatterer, 1926; (7) Kobe and Williams, 1935; (8) Orcutt and SeEVERS, 1936, 1937; (9) Kobe and Williams, 1935; (10) Shedlovsky and Molnnes, 1935; (11) Curry and Hazelton, 1938; (12) Morrison and Billett, 1952.

The data listed below are those of Bohr (1899), Geffcken (1904) and Just (1901) when unmarked (unmarked values of α and β are not necessarily from the same author). The recent determinations of Morrison and Billett (1952) were plotted and the values of β given in parentheses () were read from the graph. The results of various other authors are in excellent agreement with these. The data of Harned and Davis (1943) are apparently too high by about +.01 in β over the entire 0-50° range. Knerth's (1922) results 20-34° seem too low (about -.02 in β), as are those of Morgan and Maass (1931) from 0-25° (-.02 to -.1 in β). The data of Buch (1925) at very low partial pressures of CO₂ are erratic. Additional results are given by Bhagwat and Dahr (1929), Appel (1921), Schwab and Berninger (1928), Hantzsch and Vagt (1901) and [of the super-saturation limits] by Metschl (1924).

α = gms. CO₂ dissolved by 100 gms. H₂O at a total pressure of 760mm.
 β = ml CO₂ (measured at 0°, 760mm) dissolved in 1 ml. of H₂O when the partial pressure of CO₂ is 760mm.

C CARBON

SOLUBILITY OF CO₂ IN WATER--Cont.

t°	α	β	Other values for β	
0	0.335	1.713	1.713 (4)	1.702 (0.2°) (3)
5	.277	1.424	1.419 (6)	
10	.231	1.194	1.197 (6)	
12.5	...	... (1.075)	1.159 (4)	
15	.197	1.019(1.000)	1.022 (5)	1.014 (6)
20	.169	0.878(.865)	0.872 (6)	
23	...	...	.802 (7)	
24	...	...	.776 (7)	
25	.145	.759(.754)	.758 (7)	.757 (6)(2) .753 (8)
0			.754(9) .756(3) .750(4) .7553(10)	
			.752(11)	
30	.126	.664(.664)		
35		(.595)		
40	.097	.530(.533)		
45		(.480)		
50	.076	.436(.438)		
55		(.397)		
60		(.365)		
70		(.319)		

SOLUBILITY OF CO₂ IN ICE (Essery and Gane, 1952)

At -5° the solubility is about 1/20 that at 0°.
At -20° " " " " 1/100 " " 0°.

SOLUBILITY OF CO₂ IN DEUTERIUM OXIDE

The solubility β (Bunsen coefficient) of Carbon Dioxide in Deuterium Oxide (D₂O) at 25°, was found by Curry and Hazelton, 1938, to be 0.750 cc. CO₂ per 1 cc of D₂O. The value for the solubility of CO₂ in H₂O under identical experimental conditions was 0.752. In terms of the Bunsen coefficient the solubilities are the same within less than 1%. On a molal basis CO₂ is 0.902 times as soluble as D₂O as in H₂O.

SOLUBILITY OF CARBON DIOXIDE IN WATER AT HIGH PRESSURES

Authors:

- 0° Haehnel (1920) The data of Wroblewski (1882) are practically identical.
12° 1-30 atm. Wroblewski (1882) [actually at 12.4°]; 50-300 atm. Wiebe and Gaddy (1940).
15° Haehnel (1920).
18°-100° Wiebe and Gaddy (1940), Wiebe (1941). Prutton and Savage's data at 100° (*) are in excellent agreement.
120° Prutton and Savage (1945). The original data were expressed as mole fractions.

It may be noted that the low pressure (older) data are not always in good agreement with the more recent work.

SOLUBILITY OF CARBON DIOXIDE IN WATER AT HIGH PRESSURES—Cont.

Weibe and Gaddy also give the compositions of the vapor phases. The result of Sander (1911-12) lacks precision but is in general agreement with the data given below.

Zelvenskii (1937) determined the solubility at 0, 25, 50, 75, 100°, up to 100° atm. The equation is $S = aP + bP^2$, where

0°	25°	50°	75°	100°
$a = 1.84$	0.755	0.425	0.308	0.231
$b = -.025$	-0.0042	-0.00156	-0.000966	-0.000322

The data calculated from these equations is in fair agreement with that tabulated below, and deviates most at high pressures. 0

cc of CO₂ (measured at 0°, 1 atm.) per gram of H₂O

Total Pressure Atm.	0°	12°	15°	18°	25°	31.04° (Crit. Temp.)
1	1.80	1.09	1.00	...	...	....
5	8.71	5.15	4.59	...	...	....
10	15.89	9.65	8.39	...	...	....
15	21.82	13.63	11.85	...	...	....
20	26.53	17.11	15.21	...	...	....
25	30.46	20.34	17.64	19.51	...	14.18
30	33.65	23.25	20.31	...	...	....
35	36.73	...	22.52	...	...	....
38	37.87	...	...	...	...	....
40	...	...	24.44	...	...	....
45	...	...	25.59	...	...	....
50	...	35.54	27.06	32.03	27.23	24.15
52	...	...	27.67	...	...	....
75	...	36.33	...	33.85	31.17	29.33
100	...	36.77	...	33.98	31.75	30.17
125	...	...	...	...	...	...
150	...	38.39	...	35.75	...	31.59
200	...	39.77	...	37.17	...	32.78
300	...	41.07	...	39.31	...	...
400	...	...	...	...	38.62	36.78
500	...	...	...	...	39.74	38.67

Total Pressure Atm.	35°	40°	50°	75°	100°	120°
25	12.95	11.62	9.71	6.82	5.37	5.0
50	22.21	20.35	17.25	12.59	10.18	9.5
75	27.84	25.81	22.53	17.04	14.29	13.6
100	29.13	27.81	25.63	20.61	17.67	17.2
125	...	28.71	26.77	...	20.1*	20.1
150	30.52	29.39	27.64	24.58	22.73	22.1
200	31.83	30.74	29.14	26.66	25.69	26.8
300	...	...	31.34	29.51	29.53	30.0
400	35.73	34.87	36.29	31.88	32.39	32.8
500	37.99	36.73	...	...	34.4*	35.2
600	...	...	36.73	...	36.4*	37.5
700	...	...	38.34	37.59	38.50	39.9

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN WATER RECALCULATED INTO DEGREES FAHRENHEIT AND POUNDS PER SQUARE INCH (Heath, 1915; Anthony, 1916, see also Riley, 1911)

Pounds per Sq. Inch Pressure	Volumes of CO ₂ Gas Dissolved by One Volume of Water at:					
	32°	36°	40°	44°	48°	55°
15	3.46	3.19	2.93	2.70	2.50	2.20
20	4.04	3.73	3.42	3.15	2.92	2.57
25	4.58	4.27	3.92	3.61	3.35	2.04
30	5.21	4.81	4.41	4.06	3.77	3.31
35	5.80	5.35	4.91	4.52	4.19	3.69
40	6.37	5.89	5.39	4.97	4.61	4.05
45	6.95	6.43	5.88	5.43	5.03	4.43
50	7.53	6.95	6.36	5.89	5.45	4.80
55	8.11	7.48	6.86	6.34	5.87	5.17
60	8.71	8.02	7.35	6.79	6.29	5.53
70	9.86	9.09	8.33	7.70	7.13	6.27
80	11.02	10.17	9.31	8.61	7.98	7.00
90	12.18	11.25	10.30	9.52	8.82	7.74
100	13.34	12.33	11.29	10.43	9.66	8.4

Pounds per Sq. Inch Pressure	Volumes of CO ₂ Gas Dissolved by One volume of Water at:						
	60°	65°	70°	75°	80°	85°	90°
15	2.02	1.86	1.71	1.58	1.44	1.37	1.27
20	2.36	2.17	2.00	1.84	1.69	1.58	1.48
25	2.69	2.48	2.29	2.10	1.93	1.80	1.70
30	3.03	2.80	2.58	2.37	2.18	2.03	1.91
35	3.37	3.11	2.86	2.63	2.42	2.26	2.13
40	3.71	3.42	3.15	2.89	2.67	2.49	2.34
45	4.06	3.74	3.44	3.16	2.91	2.72	2.56
50	4.40	4.05	3.73	3.42	3.16	2.94	2.77
55	4.74	4.37	4.02	3.69	3.40	3.17	2.99
60	5.08	4.68	4.31	3.95	3.64	3.39	3.20
70	5.76	5.30	4.89	4.40	4.14	3.86	3.63
80	6.43	5.92	5.46	5.02	4.62	4.31	4.06
90	7.11	6.54	6.04	5.55	5.12	4.77	4.49
100	7.79	7.18	6.62	6.08	5.60	5.22	4.91

SOLUBILITY OF CARBON DIOXIDE IN WATER IN THE PRESENCE OF OTHER GASES (Zelvenskii, 1939)

The solubility of each gas in mixtures of CO₂ + H₂ and CO₂ + N₂ was determined at 25° and at various total pressures. β = ml. of gas (measured at 0°, 1 atm) dissolved in 1 ml. of water at room temperature.

For results at 20, 30, 35 and 50° see the table following.

SOLUBILITY OF CARBON DIOXIDE IN WATER IN THE PRESENCE OF OTHER GASES-Cont.

Pressure Atm.	Mixtures of Carbon Dioxide with Hydrogen							
	5% CO ₂		10% CO ₂		15% CO ₂		20% CO ₂	
	CO ₂	H ₂	CO ₂	H ₂	CO ₂	H ₂	CO ₂	H ₂
25	0.82	0.395	1.62	0.361	2.50	0.335	3.40	0.309
50	1.56	0.790	3.14	0.725	4.70	0.672	6.33	0.619
75	2.26	1.180	4.53	1.080	6.64	0.998	8.73	0.915
100	2.89	1.560	5.75	1.430	8.36	1.320	10.86	1.200
125	3.48	1.940	6.87	1.780	9.86	1.630	12.67	1.480
150	3.99	2.320	7.87	2.120	11.20	1.930	14.27	1.740
175	4.47	2.690	8.77	2.450	12.27	2.230	15.55	1.990
200	4.97	3.060	9.56	2.780	13.42	2.510	17.60	2.240
225	5.37	3.430	10.28	3.110	14.33	2.800	17.67	2.480
250	5.79	3.790	10.92	3.440	15.11	3.080	18.54	2.720
275	6.18	4.160	11.49	3.750	16.77	3.350	19.30	2.950
300	6.57	4.520	11.97	4.080	16.36	3.630	20.04	3.180

Pressure Atm.	Mixtures of Carbon Dioxide with Nitrogen							
	5% CO ₂		10% CO ₂		15% CO ₂		20% CO ₂	
	CO ₂	N ₂	CO ₂	N ₂	CO ₂	N ₂	CO ₂	N ₂
25	0.74	0.283	1.47	0.256	2.41	0.228	3.11	0.201
50	1.38	0.566	2.75	0.513	4.21	0.458	5.52	0.403
75	1.93	0.843	3.81	0.763	5.64	0.688	7.39	0.588
100	2.32	1.110	4.61	1.010	6.81	0.907	8.87	0.772
125	2.67	1.360	5.23	1.240	7.67	1.120	9.98	0.944
150	2.99	1.600	5.75	1.460	8.35	1.310	10.90	1.110
175	3.23	1.820	6.18	1.660	8.91	1.500	11.60	1.280
200	3.40	2.040	6.52	1.860	9.36	1.670	12.15	1.430
225	3.56	2.240	6.82	2.050	9.67	1.830	12.56	1.560
250	3.70	2.430	7.05	2.220	10.03	1.970	12.90	1.680
275	3.85	2.610	7.25	2.380	10.29	2.090	13.17	1.780
300	3.99	2.780	7.41	2.530	10.50	2.210	13.43	1.860

SOLUBILITY OF CO₂ IN MIXTURES WITH OTHER GASES AT 20, 30, 35 and 50°

Zaalishvili, 1940 studied the solubility of Carbon Dioxide in water when the Carbon Dioxide was mixed with Nitrogen and Hydrogen. At 10 atmospheres fugacity of CO₂:

Temp.	1 mol. H ₂ O dissolves:	100 grams H ₂ O dissolve:
20°	7 x 10 ⁻³ mol CO ₂	1.71 gms. CO ₂
35°	5.8 x 10 ⁻³ mol CO ₂	1.42 "
50°	4 x 10 ⁻³ "	0.98 "

Determinations of the Solubility of Carbon Dioxide mixed with Hydrogen, in Water at 20° and 30° are under total pressures up to 30 Kgs. per sq. cm. are given by Kritschewsky, Showoronkoff and Aepelbaum, 1935.

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN SOLUTIONS OF AQUEOUS ACIDS

Results in aq. H_2SO_4

(Markham and Kobe, 1941a; Kobe and Williams, 1935; Geffcken, 1904)

The data of Christoff, 1905, 1906 at 15.5° and 20° are too high.

- β = cc of CO_2 (measured at 0°, 760mm) dissolved in 1 cc of H_2O when the partial pressure of CO_2 is 760mm.
 l = cc of CO_2 (measured at t° (expt'l. temp.), 760mm) dissolved in 1 cc of H_2O when the partial pressure of CO_2 is 760mm.
 S = cc of CO_2 (measured at 0°, 760mm) dissolved in that volume of solvent which contains 1 gram of water.

0

Composition of Solvent

t°	% H_2SO_4	Moles H_2SO_4 per		Solubility			Author
		liter solution	1000 gms. H_2O	β	l	S	
15	2.42	0.250	0.253	0.965	1.018	(G.)
	4.77	0.500	0.511	.927	0.978	....
	9.25	1.000	1.039	.870	.917	....
	13.48	1.500	1.587	.825	.870	....
	17.50	2.000	2.167	.785	.828	....
25	0.0	0.0	0.0	0.7565	0.824	0.7587	(M.&K.)
	2.24	0.250	0.253	.727	.794	(G.)
	4.67	...	0.500	.6983	.762	.7127	(M.&K.)
	4.77	0.500	0.511	.705	.770	(G.)
	5.00	...	0.537	.683	.746	(K.&W.)
	8.93	...	1.000	.6650	.726	.6911	(M.&K.)
	9.25	1.000	1.039	.668	.730	(G.)
	10.00	...	1.134	.657	.717	(K.&W.)
	13.48	1.500	1.587	.639	.698	(G.)
	16.42	...	2.000	.6132	.669	.6610	(M.&K.)
	17.50	2.000	2.167	.611	.667	(G.)
	22.7	...	3.00	.58546546	(M.&K.)
	28.1	...	4.00	.5740	...	.6659
	37.1	...	6.00	.5878	...	.7332
	44.0	...	8.00	.6159	...	.8238
	49.5	...	10.00	.6337	...	.9053
	58.0	...	14.15	.6404	...	1.0372	
	64.9	...	18.86	.6225	...	1.1453	
	73.5	...	28.29	.5840	...	1.3386	
	78.8	...	37.72	.5659	...	1.5573	
	84.9	...	56.58	.7541	...	2.1232	
	90.3	...	94.30	.645	...	....
	94.9	...	188.60	.753	...	....
	96.5	...	282.90	.813	...	....
	97.4	...	565.80	.880	...	....
	99.1	...	1131.60	.920	...	....
	100	...	.....	.960	...	....

-For data on the solubility of CO_2 in H_2SO_4 - Na_2SO_4 solutions see page 251.-The solubility of CO_2 in H_2SO_4 . HCl solutions is given by Wolf and Krause, 1927.

SOLUBILITY OF CARBON DIOXIDE IN SOLUTIONS OF AQUEOUS ACIDS--Cont.

Results in aq. HCl

(Geffcken, 1904; Van Slyke, Sendroy, Jr. Hastings and Neill, 1928)

t°	Moles HCl per Liter	β	l	Author
15	0.5	0.982	1.043	Geffcken, 1904
	1.0	0.975	1.028	
	2.0	0.948	1.000	
25	0.5	0.738	0.806	
	1.0	0.732	0.799	
	2.0	0.728	0.795	
38	0.01	0.5455	...	V., S., H. & N. 1928
	0.256	0.5384	...	
	0.300	0.5364	...	

Results in HCl - Salt Mixtures at 38°

(Van Slyke, Sendroy, Hastings and Neill, 1928)

Molarity of Solvent	β	Molarity of Solvent	β
0.01 HCl + 0.150 NaCl	0.529	0.01 HCl + 0.150 KCl	0.532
0.01 HCl + 0.300 NaCl	0.512	0.01 HCl + 0.300 KCl	0.520

Results in aq. HNO₃

(Geffcken, 1904)

Moles HNO ₃ per liter	15°		25°	
	β	l	β	l
0.5	1.021	1.078	0.769	0.840
1.0	1.030	1.086	0.782	0.853
2.0	1.042	1.100	0.804	0.877

Results in aq. HClO₄ at 25°

(Markham and Kobe, 1941a)

α = cc of CO₂ (measured at 0°, 760 mm) dissolved in 1 cc. of water
 S = cc of CO₂ (measured at 0°, 760 mm) dissolved in that volume of
 solvent which contains one gram of water.
 The partial pressure of CO₂ was 760 mm in each determination.

Moles HClO ₄ per 1000 gms. H ₂ O	β	S	Moles HClO ₄ per 1000 gms. H ₂ O	β	S
0.0	0.7565	0.7587	2.00	.798	.865
.25	.753	.764	4.00	.835	.984
.50	.759	.778	6.00	.863	1.091
.75	.765	.793	10.00	.866	1.239
1.00	.772	.809	15.47	.762	1.264
1.50	.785	.840	22.84	.718	1.426

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN SOLUTIONS OF AQUEOUS ACIDS--Cont.

Results in aq. H_3PO_4 and Acid-Salt Mixtures at 38°
 (Van Slyke, Sendroy, Hastings and Neill, 1928)

Molarity of Solvent

0.150 H_3PO_4	0.5396
0.300 "	0.5317
0.015 H_3PO_4 + 0.15 KH_2PO_4	0.5163
0.30 " + 0.30 "	0.4906
0.011 H_3PO_4 + 0.037 NaH_2PO_4	0.5360
0.019 " + 0.075 "	0.5272
0.024 " + 0.120 "	0.5175
0.015 " + 0.150 "	0.5109
0.030 " + 0.300 "	0.4791

Results in aq. Citric Acid at 15.2°
 (Setschenow, 1892)

Gms. citric acid per liter	cc CO_2 (S.T.P.) per cc of sat'd. soln.	Gms. citric acid per liter	cc CO_2 (S.T.P.) per cc of sat'd. soln.
12	1.007	198	0.893
49	0.975	298	0.841
99	0.950	575	0.719

Results in aq. Lactic Acid and Acid-Salt Mixtures at 38°
 (Van Slyke, Sendroy, Hastings and Neill, 1928)

Molarity of Solvent	β	Molarity of Solvent	β
0.100 lactic acid	0.5458	0.10 lactic acid + 0.15 Na lactate	0.5214
0.150 "	0.5473	0.15 " " + 0.15 " "	0.5220
0.300 "	0.5433	0.10 " " + 0.30 " "	0.5023
		0.30 " " + 0.30 " "	0.4980
		0.10 " " + 0.15 K "	0.5278
		0.15 " " + 0.15 " "	0.5288
		0.10 " " + 0.30 " "	0.5106
		0.30 " " + 0.30 " "	0.5103

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF FERRIC HYDROXIDE
 (Gatterer, 1926)

An apparatus designed to eliminate the disadvantages of the Ostwald apparatus was used.

Normality of Ferric hydroxide Solution	Solubility of CO_2 at:				
	25°	20°	15°	10°	5°
0.000 ($=H_2O$) ...	0.826	0.936	1.070	1.240	1.446
0.071	0.8533	0.9610	1.095	1.267	1.471
0.144	0.8764	0.9870	1.123	1.297	1.503
0.293	0.9063	1.016	1.154	1.326	1.534
0.513	0.9526	1.066	1.204	1.379	1.584
0.967	1.032	1.149	1.291	1.470	1.680

(Cont.)

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF FERRIC HYDROXIDE--Cont.
Data of Findlay and Harby, 1908

Wt.% Fe(OH) ₃ (dialyzed) :	0.136	0.34	0.68	1.36
Solubility : l :	0.824	0.833	0.877	0.896

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS

Results in aqueous NaCl

Authors: 0.58, 1.16, 2.26, 5.53, 10.47, 14.93, 18.94% (Markham and Kobe, 1941)
7.06, 13.00, 17.42, 26.00% (Mackenzie, 1877)
10.00, 20.00, 25.00% (Kobe and Williams, 1935)
6.53, 17.62% (Bohr, 1899; Geffcken, 1904; Just, 1901)
1.3, 6.1, 11.8, 17.2% (Settschenow, 1892 (at 15.2°))

A series of determinations by Harned and Davis (1943) from 0-50°, 0-15% NaCl are somewhat higher (0.01-.04 in β) than those given in the composite table below. Since these authors also found high values in water alone (see p. 459), their results have not been included. They are given separately in the table following.

Values for β (ml CO₂ (S.T.P.) dissolved in 1 ml solvent when pp. CO₂ = 1 atm.).

Wt.% NaCl in Solvent
(Values in parentheses are molalities)

t°	0.58 (.1m)	1.16 (.2m)	1.3	2.26 (.5m)	5.53 (1.0m)	6.1	6.53
0	1.278 ²	...	1.234
5	1.024
6.4
10	0.875
15	0.978 ¹	...	...	7.60 ¹	0.755
20	0.664
22
25	0.738	0.720	...	0.669	0.595	...	0.583
30	0.517
40	0.408	...	0.414
50	0.370
60	0.305

t°	7.06	10.00	10.47 (2.0m)	11.8	13.00	14.93 (3.0m)	17.2
0	0.988 ²	...	...	0.780 ²	...
5
6.4	0.899	...	...	...	0.633	...	...
10
15	0.735	...	...	0.580 ¹	0.557	...	0.466 ¹
20
22	0.482	...	...
25	...	0.505	0.482	...	...	0.392	...
30
40	0.333	...	...	0.277	...
50
60

¹at 15.2°

²at 0.2°

(Cont.)

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS--Cont.

Wt. % NaCl in Solvent--Cont.
(Values in parentheses are molalities)

t°	17.42	17.62	18.94 (4.0m)	20.00	25.00	26.00
0	...	0.678	0.689 ²	...	...	...
5	...	0.577	...	...	...	...
6.4	0.518	...	...	...	...	0.347
10	...	0.503	...	...	...	...
15	0.431	0.442	...	...	...	0.297
20	...	0.393	...	...	...	...
22	0.389	...	...	...	...	0.263
25	...	0.352	0.329	0.310	0.236	...
30	...	0.319	...	...	...	...
40	...	0.263	...	...	...	...
50	...	0.235	...	...	...	...
60	...	0.183	...	...	...	...

²at 0.2°

The results of Harned and Davis (1943) are given below. These data are 0.01-0.04 higher in β than those in the preceding composite table. They are expressed in terms of grams of CO₂ dissolved in 1000 gms. of solvent at 1 atm. pressure of CO₂. To convert these to β , multiply by 0.509.

Temp.	Gram Moles NaCl per 1000 gms. Water					
	0.0	0.2	0.5	1.0	2.0	3.0
0°	3.383	3.202	2.951	2.585	2.029	1.640
5°	2.818	2.673	2.470	2.174	1.722	1.399
10°	2.367	2.247	2.079	1.835	1.469	1.201
15°	2.007	1.905	1.765	1.569	1.263	1.043
20°	1.727	1.641	1.525	1.357	1.103	0.915
25°	1.514	1.444	1.344	1.200	0.979	0.816
30°	1.327	1.267	1.182	1.053	0.867	0.727
35°	1.179	1.127	1.054	0.948	0.781	0.654
40°	1.053	1.010	0.946	0.851	0.701	0.589
45°	0.964	0.920	0.921	0.771	0.636	0.533
50°	0.868	0.831	0.779	0.702	0.578	0.483

Wolf and Krause (1927) determined the solubility of Carbon Dioxide in solutions of CaCl₂ + NaCl which were used as retaining liquids in gas analysis.

Results in aqueous KCl

Authors: 0.2°, 25°, 40° (Markham and Kobé, 1941)
25° with densities given (Findlay and Shen, 1912)
8°, 15°, 22° (Mackenzie, 1877)
15°, 25° (Geffcken, 1904) [^aconcentrations in gms. NaCl per liter]

Data for KCl solutions at higher pressures are given by Findlay and Creighton (1910).

(Cont.)

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS--Cont.

Results in aqueous KCl--Cont.

Values for β

Solvent			Temperature					
moles KCl per 1000 gms. H ₂ O	gms. KCl per 1000 - gms. H ₂ O	Density	0.2°	8°	15°	22°	25°	40°
0.1	7.46	....	1.661	...	...	...	0.743	...
0.2	14.91	....	1.627	...	...	...	0.731	...
...	18.6	1.008(25°)	...	...	...	...	0.726	...
...	30.9	1.017(25°)	...	...	...	...	0.700	...
...	37.3 ^a	....	...	...	0.925	...	0.695	...
0.5	37.3	....	1.529	...	...	...	0.694	...
...	46.8	1.026(25°)	...	...	...	...	0.686	...
...	64.4	1.021(15°)	...	0.988	...	0.670	...	...
...	74.55 ^a	....	...	...	0.850	...	0.641	...
1.0	74.55	....	1.402	...	...	...	0.644	0.436
...	76.9	1.044(25°)	...	...	...	...	0.642	...
...	94.8	1.053(15°)	...	0.918	0.777	0.649	...	...
...	136.1	1.080(15°)	...	0.864	0.720	0.597	...	...
2.0	149.1	....	1.198	...	...	...	0.565	0.385
3.0	223.7	....	1.046	...	...	...	0.503	0.325
...	290.6	1.549(15°)	...	0.688	0.571	0.480	...	...
4.0	298.2	....	...	...	...	...	0.456	...

^agms. per liter sat. soln.Results in aqueous NH₄Cl

Authors: 8, 10, 15, 22° (Mackenzie, 1877)

15.2° (^a) (Setschenow, 1892)

25° (Findlay and Shen, 1912)

Values for β

Solvent		Temperature				
Gms. NH ₄ Cl per liter	Density	8°	10°	15°	22°	25°
1	....	...	...	1.005 ^a	...	...
10	....	...	...	0.985 ^a	...	...
23.5	1.005(25°)	...	...	...	...	0.725
50.5	1.013(25°)	...	...	...	...	0.690
51.6	....	...	...	0.941 ^a	...	...
66.1	1.021(15°)	1.023	...	0.825	0.718	...
91.4	1.047(15°)	1.000	...	0.791	0.702	...
100.3	1.022(25°)	...	...	...	...	0.670
134.1	1.053(15°)	0.922	...	0.798	0.684	...
170.9	1.045(25°)	...	...	...	...	0.609
172	....	...	...	0.819 ^a	...	...
258	....	...	...	0.770 ^a	...	...
260	1.072(15°)	...	0.813	0.738	0.600	...

^a = at 15.2°

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS--Cont.

Results in Solutions of Other Salts

- | | |
|----------------------------------|----------------------------|
| (1) Kobe and Williams, 1935 | (5) Geffekan, 1904 |
| (2) Mackenzie, 1877 | (6) Bhagwat and Dahr, 1929 |
| (3) Findlay and Shen, 1912 | (7) Markham and Kobe, 1941 |
| (4) Setschenow, 1892 | |
| (further data given in original) | |

A number of determinations done by Christoff (1905) are considered unreliable.

0

Salt	t°	Conc'n. of Salt soln.	Solubility of CO ₂ A		Salt	t°	Conc'n. of Salt soln.	Solubility of CO ₂ A	
AlCl ₃	25	25 wt. %	0.222	(1)	Ca(NO ₃) ₂	15.2	41 g./l.	0.923	(4)
Al ₂ (SO ₄) ₃	25	20 wt. %	0.203	(1)	CsCl	15	84.17 g./l.	0.953	
BaCl ₂	8	7.316 wt. %	0.969			25	84.17 g./l.	0.715	(5)
		9.753 ^b	1.021		FeSO ₄ .	25	95.1 ^m g./l.	0.587	
		25.215 ^d	0.495		(NH ₄) ₂ .SO ₄ .		102.6 ⁿ	0.576	(3)
	16.5	7.316 wt. %	0.744		CH ₃ O		224.7 ^o	0.422	
		9.753 ^b	0.645		KBr	15	59.55 g./l.	0.935	(5)
		14.030 ^c	0.618	(2)			119.11	0.866	
		25.215 ^d	0.618			15.2	83.9 g./l.	0.908	
	22	7.316 wt. %	0.680				167.7	0.819	(4)
		9.753 ^b	0.607				251.5	0.748	
		14.030 ^c	0.524				503.1	0.579	
		25.215 ^d	0.383			25	59.55 g./l.	0.704	(5)
	25	2.83 wt. %	0.722				119.11	0.653	
		5.92 ^f	0.679	(3)	KI	15	83.06 g./l.	0.940	(5)
		8.388	0.650				166.12	0.875	
		10.26 ^h	0.619			15.2	319.1 g./l.	0.777	(4)
	30	7.316 wt. %	0.566				478.6	0.688	
		9.753 ^b	0.543	(2)			937.3	0.506	
		14.030 ^c	0.467			25	83.06 g./l.	0.710	(5)
		25.215 ^d	0.315				166.12	0.666	
Ba(NO ₃) ₂	15.2	62.7g./l.	0.922	(4)			Gm. mols. per liter		
CsCl ₂	8	4.365 wt. %	0.942				KF	CO ₂	
		5.739 ^k	0.855			25	0.619	0.1295	
		8.045 ^k	0.838				1.238	0.1504	
		15.793 ⁱ	0.632		KF	30	0.7428	0.1156	
	16.5	4.365 wt. %	0.759	(2)			0.9904	0.1320	
		5.739 ^k	0.726				Gm. mols. per liter		
		8.045 ^k	0.674				K ₂ Cr ₂ O ₇	CO ₂	
		15.793 ⁱ	0.520			30	0.1250	0.1500	
	22	4.365 wt. %	0.673				0.2154	0.1760	
		5.739 ^k	0.616				0.2396	0.2143	
		8.045 ^k	0.581				0.2500	0.1973	
		15.793 ⁱ	0.471				0.3482	0.2460	
	25	40	0.144	(1)	K ₂ Cr ₂ O ₇		0.3962	0.2541	
	30	4.365 ^j	0.596				0.4309	0.2637	
		5.739 ^j	0.527	(2)			0.500 [!]	0.2601	
		8.045 ^k	0.500				1.000	0.3684	
		15.793 ⁱ	0.400				Gm. mols. per liter		
							K ₂ MoO ₄	CO ₂	
						25	0.04096	0.0802	
							0.1024	0.0951	
							0.2048	0.1200	
							0.4096	0.1686	

75-120 The solubility of carbon dioxide in water and in calcium chloride solutions at 75°, 100°, and 120° at pressures up to 700 atmospheres was determined by Prutton and Savage (1945). The results are expressed in terms of the mole fraction of carbon dioxide in the solution at each temperature and pressure. 10%, 20%, and 30% calcium chloride solutions were used.

$$\begin{array}{llll} d_{d_1 s}^* = 1.068 & b_{d_1 s}^* = 1.092 & c_{d_1 s}^* = 1.137 & d_{d_1 s}^* = 1.273 \\ f_{d_1 s}^* = 1.040 & g_{d_2 s}^* = 1.054 & h_{d_2 s}^* = 1.070 & i_{d_1 s}^* = 1.036 \\ k_{d_1 s}^* = 1.068 & l_{d_1 s}^* = 1.139 & m_{d_2 s}^* = 1.052 & n_{d_2 s}^* = 1$$

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS—Cont.

Results in Solutions of Other Salts—Cont.

- (1) Kobe and Williams, 1935 (5) Geffcken, 1904
 (2) Mackenzie, 1877 (6) Bhagwat and Dahr, 1929
 (3) Findlay and Shen, 1912 (7) Markham and Kobe, 1941
 (4) Setschenow, 1892
 (further data given in original)

A number of determinations done by Christoff (1905) are considered unreliable.

unreliable.

Salt	t°	Gm. mols. per liter		Salt	t°	Moles Mg(NO ₃) ₂ per 1000 gms. H ₂ O		p	0		
		KIO ₃	CO ₂								
KIO ₃	18	0.6879	0.09505	(6)	Mg(NO ₃) ₂	0.2	0.5	1.393	(7)		
	19	0.1375	0.08164			1.0	1.144				
		0.3437	0.08373			2.0	0.785				
K ₂ TiO ₃	17	Gm. mols. per liter				25	3.0	0.561	(7)		
		K ₂ TiO ₃	CO ₂				0.5	0.648			
		0.0015	0.08854				1.0	0.559			
		0.0035	0.09585				2.0	0.420			
		0.0050	0.1149				3.0	0.323			
KNO ₃	0.2	Moles KNO ₃ per 1000 gms. H ₂ O				40	0.5	0.446	(7)		
		0.1	1.668				1.0	0.390			
		0.2	1.647				2.0	0.302			
		0.5	1.573				3.0	0.238			
		1.0	1.461								
15	50.59g./l.	0.953	(5)	15.2	26.5 g./l.	0.901	(4)				
	101.19	0.897			79.5	0.669					
	58.8 g./l.	0.959			159	0.441					
15.2	117.5	0.890	(4)		318	0.188	(4)				
	235.1	0.781									
	50.59 g./l.	0.718									
25	101.19	0.686	(5)								
KSCN	0.2	Moles KNO ₃ per 1000 gms. H ₂ O		(6)	MgSO ₄	0.2	0.5	1.199	(7)		
		0.1	1.668				1.0	0.844			
		0.2	1.647				2.0	0.413			
		0.5	1.573				26.5 g./l.	0.901			
	15	50.59g./l.	0.953		(5)		15.2	79.5	0.669	(4)	
		101.19	0.897					159	0.441		
		58.8 g./l.	0.959					318	0.188		
	15.2	117.5	0.890		(4)						
		235.1	0.781								
		50.59 g./l.	0.718								
	25	101.19	0.686		(5)						
LiCl	0.2	Moles KNO ₃ per 1000 gms. H ₂ O		(7)	(NH ₄) ₂ SO ₄	15.2	0.5	0.558	(7)		
		0.1	0.750				1.0	0.415			
		0.2	0.724				2.0	0.225			
		0.5	0.718				0.5	0.381			
	15	1.0	0.686		(4)		40	1.0	0.295	(4)	
		2.0	0.630					2.0	0.166		
		3.0	0.582					72.2 g./l.	0.712		
	15.2	40	0.470		(7)			144.4	0.575	(4)	
		2.0	0.437								
		3.0	0.408								
	MgCl ₂	25	326 g./l.		0.691	(4)	(NH ₄) ₂ MoO ₄	20.5	0.0854	0.0758	(6)
			489		0.590				22	0.0893		0.0721
978			0.387	23	0.0841				0.0700		
16.72 g./l.			1.035	Gm. mols. per liter							
50.15			0.808	(NH ₄) ₂ MoO ₄	CO ₂						
MgCl ₂	25	125.4	0.596	(4)							
		250.8	0.497								
		501.5	0.120								
		30 wt. %	0.150				Gm. mols. per liter				
							(NH ₄) ₂ MoO ₄	CO ₂			

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS--Cont.

Results in Solutions of Other Salts--Cont.

- | | |
|-----------------------------|----------------------------|
| (1) Kobe and Williams, 1935 | (5) Geffcken, 1904 |
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- (further data given in original)

A number of determinations done by Christoff (1905) are considered unreliable.

0

Gm. mols. per liter				Gm. mols. per liter										
Salt	t°	(NH ₄) ₂ MoO ₄	β			NaH ₂ PO ₂	CO ₂							
NH ₄ NO ₃	15.2	2.8 g./l.	1.013	(4)	NaH ₂ PO ₂	25	0.2424	0.0745	(6)					
		11.2	1.002				0.4849	0.0786						
		55	0.989				0.9698	0.08554						
		101	0.962				0.1407	0.0703						
		202.1	0.911			27	Gm. mols. per liter							
		404.3	0.807				Na ₂ HPO ₃	CO ₂						
Na ₂ B ₄ O ₇	16	810.4	0.612	(6)	NaH ₂ PO ₃	21	0.4615	0.1945	(6)					
		Gm. mola. per liter					0.6153	0.2295						
		Na ₂ B ₄ O ₇	CO ₂				0.3846	0.2055						
		0.0924	0.2664				0.7692	0.2337						
		0.2156	0.4213			26.5	2.2015	0.2322						
		0.1540	0.3470				10 wt. %	0.256						
NaBr	15.2	0.3080	0.5288	(4)			14.2 g./l.	0.950	(4)					
		β					94.8	0.620						
		115.1 g./l.	0.775				284.4	0.234						
		NaClO ₃	15.2	460.3		0.364	25	Moles Na ₂ SO ₄ per 1000 gms. H ₂ O						
				690.4		0.221		β						
				233.3 g./l.		0.625		0.25		0.634				
349.9	0.506			(4)				0.5	0.533	(7)				
699.8	0.257							1.0	0.386					
Moles NaNO ₃ per 1000 gms. H ₂ O								1.5	0.282					
β		1.76	0.240											
NaNO ₃	0.2	0.2	1.617	(7)		40	0.25	0.439						
		0.5	1.504				0.5	0.374						
		3.0	0.884				(7)			1.0	0.278	(7)		
		8.0	0.406							1.5	0.207			
		89.3 g./l.	0.835							Gm. mols. per liter				
		125	0.762							Na ₃ VO ₄	CO ₂			
NaNO ₃	15.2	208.4	0.621	(4)		Na ₃ VO ₃	21	0.3117	0.5944	(6)				
		216.8	0.385					0.4646	0.7177					
		625.2	0.244					β						
		Moles NaNO ₃ per 1000 gms. H ₂ O						60.47 g./l.	0.937	(5)				
		β					120.95	0.874						
		0.1	0.742				60.47 g./l.	0.705						
NaNO ₃	25	0.2	0.729	(7)		SrCl ₂	8	120.95	0.7227					
		0.5	0.695		9.511Prt. %			0.779						
		1.0	0.635		12.3259			0.737						
		2.0	0.541		17.713 ^r			0.606						
		3.0	0.466		31.194 ^s		0.285							
		8.0	0.247		9.511Prt. %		0.663							
NaNO ₃	16.5	0.1	0.742	(7)	16.5	16.5	12.3259	0.586	(2)					
		0.2	0.729				17.713 ^r	0.473						
		0.5	0.695				31.194 ^s	0.245						
		1.0	0.635				β							
		2.0	0.541				β							
		3.0	0.466				β							

$$P_{d_{15}}^{\circ} = 1.087 \quad Q_{d_{15}}^{\circ} = 1.116 \quad R_{d_{15}}^{\circ} = 1.173 \quad S_{d_{15}}^{\circ} = 1.343$$

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS SALT SOLUTIONS--Cont.

Results in Solutions of Other Salts

- | | |
|-----------------------------|----------------------------|
| (1) Kobe and Williams, 1935 | (5) Geffcken, 1904 |
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- (further data given in original)

A number of determinations done by Christoff (1905) are considered unreliable.

Salt	t°	β	β	0
SrCl ₂	22	9.511Pwt.%	0.581	ZnCl ₂ 25 50wt.% 0.354 (1)
		12.325 ^g	0.507	
		17.713 ^r	0.444	
		31.194 ^s	0.247	
		31.194 ^s	0.223	
	30	9.511Pwt.%	0.508	ZnSO ₄ 15.2 38.3 g./l. 0.903
		12.325 ^g	0.439	
		17.713 ^r	0.367	
		31.194 ^s	0.223	

$$Pd_{15}^{\circ} = 1.087 \quad qd_{15}^{\circ} = 1.116 \quad rd_{15}^{\circ} = 1.173 \quad sd_{15}^{\circ} = 1.343$$

Buch (1910) determined the partial pressures of carbon dioxide and ammonia over solutions containing ammonium carbonate and ammonium carbamate in varying proportions.

The partial pressures of carbon dioxide, ammonia, and water were determined over solutions of ammonium chloride + ammonium sulfate (Belopolsky, Shpunt, and Palkina, 1941), and over $Cu(NH_3)_4^{++}$ solutions (Zhavoronkov, 1939).

The liquid-vapor equilibrium of the system $CO_2 + H_2O + K_2O + SiO_2$ was determined at 500° by Morey and Fleischer (1940). The distribution of CO_2 between liquid and vapor is reported as a function of pressure and solution composition.

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF PRUSSIAN BLUE (Gatterer, 1926)

The Prussian Blue solution (Ferri ferrocyanide) was prepared from sodium ferrocyanide and ferric chloride. The gram equivalent was taken as $\frac{1}{2}Fe_4[Fe(CN)_6]_3 = 71.603$ for purposes of calculation. The solubility of CO_2 is given in terms of the Ostwald Solubility Expression, l .

Normality of Prussian Blue solution	Solubility l of CO_2 at				
	25°	20°	15°	10°	5°
0.896	0.8421	0.9512	1.087	1.255	1.453
0.51	0.8505	0.9613	1.093	1.264	1.464
0.37	0.8577	0.9684	1.106	1.277	1.478
0.178	0.853	0.9633	1.098	1.268	1.472
0.126	0.8443	0.9549	1.089	1.258	1.465

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN SEA WATER

Data for the Solubility of CO_2 in sea water are given by Hamberg (1885)

According to Fox (1909a), analyses of sea water all show an excess of base over acid, that is, when CO_2 is left out of account. This CO_2 (about 50 cc. per liter) is, of course, in equilibrium with the excess of base, which is actually equal to about 40 mgs. OH per liter. The partial pressure of CO_2 very seldom, if ever, exceeds 6 in 10,000. For the determination of the absorption coefficient of CO_2 there are, consequently, four independent variables to be considered; influence of alkalinity, a chemical influence in addition to the purely physical influences of temperature, pressure and salinity. For convenience, the dissolved CO_2 may be considered as made up of two parts, about 1% dependent upon physical influences alone and a far larger part dependent upon the alkalinity, pressure and temperature, but independent of salinity. Extensive experimental determinations are described.

A critical review of the literature on the solubility of carbon dioxide in water and in sea water is given by Coste (1917).

SOLUBILITY OF CARBON DIOXIDE IN SOLUTIONS OF COLLOIDS, SUSPENSIONS, ETC.

Data for the influence of colloids and fine suspensions upon the solubility of carbon dioxide in water at 25° and at various pressures are given by Findlay, 1908; Findlay and Creighton, 1910, 1911; Findlay and Shen, 1911, 1912; Findlay and Williams, 1913; Findlay and Howell, 1915.

The solubility of CO_2 increases slightly with increasing concentrations of $\text{Fe}(\text{OH})_3$, gelatin, silicic acid, aniline (chem. combination occurs), methyl orange, blood, serum, peptone, protopeptone, and commercial hemoglobin. The solubility diminishes slightly with increasing concentrations of arsenious sulfide, dextrine, soluble starch, glycogen (?), egg albumen and serum albumen. No appreciable effect is produced by suspensions of charcoal or silica.

When the solubility is increased by a given substance, the solubility curve falls with increase of pressure; when it is lessened, the curve rises with increasing pressure. In the case of starch and other neutral colloids, the solubility passes through a minimum with increase of pressure.

Data for the influence of colloids and suspensions on the evolution of CO_2 from supersaturated solutions, are given by Findlay and King, 1913-14.

Data of Findlay and Harby, 1908:

The carbon dioxide used contained 0.7% of foreign gases 1 = ml. CO_2 (measured at 25° , 760 mm) dissolved in 1 ml. of solvent.

Solute	Wt. %	l	Solute	Wt. %	l
None	....	0.823	H_2SiO_3	0.113	0.823
$\text{Fe}(\text{OH})_3$	1.36	.896		.068	.822
(dialyzed)	0.68	.877	Dextrin	20	.735
	.34	.833		10	.757
	.136	.824		5	.768
Gelatin	5	.848		1	.817
	3	.834	Soluble starch	10	.776
	1	.826		5	.801

Data of Findlay and Harby, 1908--Cont.:

Solute	Wt. %	l	Solute	Wt. %	l
As ₂ S ₃	0.305	0.822	Soluble starch--	1	0.815
	.244	.825	Cont.		
	.122	.825	Glycogen	1.18	.804
	.0244	.825		0.263	.820
			Albumin	.5	.822
				.75	.822

SOLUBILITY OF CARBON DIOXIDE AT 38° IN NORMAL PLASMA AND
 SERUM ACIDIFIED WITH 0.1 GM. MOL. LACTIC ACID PER LITER
 (Van Slyke, Sendroy, Hastings and Neill, 1928)

Solvent	Mm. CO ₂ tension at 38°	Bunsen Absorp. Coef. B of CO ₂
Ox Serum	706	0.509
" "	709	0.511
Normal Human Serum	709	0.506
" " Oxalate Plasma	700	0.511

The authors also give results for the effect of lipoids upon the solubility of CO₂ in plasma and serum. They also give results for the solubility of CO₂ in acidified aqueous solutions of ox cells at 38°.

On the basis of calculations from their experimental determinations the authors state that "The measurable deviations of the solubility of CO₂ in serum from its solubility in water have been found due to the following factors: Salts, depressing the solubility about 3 percent by lowering the solvent power of the water for CO₂, and to a lesser extent by displacing a small amount of water; proteins, depressing the solubility of CO₂ per cc. of serum several percent by displacing water; lipoids, raising the solubility (by about 4 percent in normal serum) because of their own high solvent power for CO₂. The combined effort is to reduce the solubility in normal serum to 93 to 94 percent of its solubility in water."

Data for the absorption of CO₂ by hemoglobin are given by Jolin, 1889.

Data for the solubility of CO₂ in blood and plasma, quoted from Bohr, are given by O'Brien and Parker, 1922.

SOLUBILITY OF CARBON DIOXIDE IN URINE
 (Mainzer and Bruhn, 1931)

In 20 samples of urine measured under a variation of pressure of CO₂ between 13.3 and 242.4 mm. Hg the absorption coefficient of CO₂ at 38° varied between 0.441 and 0.514

In studying the effect of Chlorophyll upon the solubility of carbon dioxide, Kremann and Schinderschitsch, 1916, found the solubility coefficient in 95% alcohol to be ι_{16} = 2.44, 2.48 and 2.53. The corresponding figure for a 95% alcoholic solution of chlorophyll was ι_{16} = 2.37 (in the light) and 2.44 (in the dark). These values all agree with the data of Winkler and show no appreciable effect on the solubility of CO₂, resulting from the presence of chlorophyll.

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN ETHANOL

Results in Absolute Ethanol
(Data of Bunsen (1877) as recalculated by Henrich (1892))

t° =	0	5	10	15	20	25
β =	4.329	3.899	3.510	3.194	2.938 (2.95)*	2.745

*Kosakewitsch, 1929.

The values of Kunerth, 1922 are lower than these, but his results in pure water are also too low. They may be found in the table on page 480.

SOLUBILITY IN ETHANOL AT -78° AND -59° (Stern, 1912, 1913)

K' = cc of CO₂ measured at 0° absorbed by 1 gram of solvent at the pressure given.

(β = K' x density)

l = Ostwald coefficient

t°	Pmm. Hg	K'	l	t°	Pmm. Hg	K'	l
	50	107.0	..		100	40.85	27.27
(d ₄ ^{-78°} = 0.872)	100	111.8	68.4	(d ₄ ^{-59°} = 0.856)	200	41.00	27.16
	200	115.7	69.5		400	42.35	27.65
	400	123.8	71.4		700	44.15	28.10
	700	138.6	74.7				

SOLUBILITY IN ETHANOL AT HIGH PRESSURE (Sander, 1911-12)

See first column in the table on page 482.

RESULTS IN AQUEOUS ETHANOL (Bohr, 1900; Just, 1901 (97%))

In 99 percent Alcohol			In 98.7 percent Alcohol		In 97 percent Alcohol
cc. CO ₂ (at 0° and 760 mm.) per 1 cc.			cc. CO ₂ (at 0° and 760 mm.) per 1 cc.		
t°	Alcohol	Sat. Solution	Alcohol	Sat. Solution	t° l (Ostwald Coeff.)
-65	38.41	35.93	39.89	37.22	15 3.130
-20	7.51	7.41	7.25	7.16	20 2.923
-10	5.75	5.69	5.43	5.38	25 2.706
0	4.44	4.40	4.35	4.31	
+10	3.57	3.55	...	...
20	2.98	2.96	...	...
25	2.76	2.74	...	...
30	2.57	2.56	...	...
40	2.20	2.19	...	...
45	2.01	2.00	...	...

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS
OF ETHYL ALCOHOL AT 15°
(Showalter and Ferguson, 1936)

Wt. percent C ₂ H ₅ OH in solvent	Vapor pressure of the pure solution in mm. Hg	Bunsen abs. coef. β of CO ₂
0.0 (= H ₂ O)	12.7	1.022
7.7	15.5	0.991
12.2	17.5	0.9545
24.0	21.5	0.8427
34.5	25.0	0.8550
52.6	29.0	1.139
90.8	31.2	2.546
91.8	31.8	2.556
95 (16°)	..	2.35*

0

*Kremann and Schinderschitsch, 1916.

SOLUBILITY IN AQUEOUS ALCOHOL AT 20°
(Muller, 1889; Lubarsch, 1889)

Density of Alcohol	Percent Alcohol by Wt.	Abs. Coef. of CO ₂ , β .	Density of Alcohol	Percent Alcohol by Wt.	Abs. Coef. of CO ₂ , β .
0.998	1.07	0.861	0.922	49.0	0.982
0.969	22.76	0.841	0.870(18.8°)	71.1	1.293
0.960(22.4°)	28.46	0.792	0.835(16°)	85.3	1.974
0.956	31.17	0.801	0.795(19°)	99.7	2.419
0.935(17°)	42.15	0.877			

SOLUBILITY IN AQUEOUS ALCOHOL AT 25°
(Findlay and Shen, 1911)

Results for alcohol,
of $d_{4}^{25} = 0.9931$
(2.95 gms. per 100 cc.)

Results for alcohol,
of $d_{4}^{25} = 0.9929$
(3.01 gms. per 100 cc.)

Pressure m.m. Hg.	Solubility of CO ₂ , Ostwald Expression ι_{25}	Pressure m.m. Hg.	Solubility of CO ₂ , Ostwald Expression ι_{25}
737	0.812	745	0.814
836	0.813	937	0.815
1073	0.811	1083	0.813
1338	0.811	1357	0.812

C CARBON

SOLUBILITY IN AQUEOUS ALCOHOL AT 25°--Cont.

Results for alcohol,
of $d_{4}^{25} = 0.9834$
(8.83 gms. per 100 cc.)

Pressure m.m. Hg.	Solubility of CO ₂ , Ostwald Expression l_{25}
747	0.786
942	0.784
1090	0.785
1360	0.788

These authors also showed that the solubility of CO₂ in wort containing 13 gms. solids per 100 cc. is less than in water; also that the solubility of CO₂ in beer is less than in aqueous alcohol solutions of alcohol content equal to that of the beer.

SOLUBILITY IN DILUTE ETHANOL SOLUTIONS AT 0, 12.5, 25°
(Kiss, Lajtai and Thury, 1937)

Composition of aqueous solvent in gm. mols. per liter	Gm. mols. CO ₂ dissolved per liter sat. sol. at:			Ostwald Sol. Expression for CO ₂ dissolved at:		
	0.05°	12.5°	25°	0.05°	12.5°	25°
0.0 C ₂ H ₅ OH	0.07640	0.04944	0.03385	1.713	1.159	0.8190
2.0 "	0.06616	0.04534	0.03255	1.484	1.063	0.7966
4.0 "	0.05423	0.04094	0.03100	1.216	0.960	0.7500
6.0 "	0.04516	0.03573	0.02900	1.013	0.838	0.7016
8.0 "	0.04556	0.03800	0.03310	1.022	0.891	0.8008
10.0 "	0.05123	0.04401	0.03893	1.149	1.032	0.9418
12.0 "	0.06754	0.05709	0.04932	1.515	1.339	1.193
14.0 "	0.09001	0.07351	0.06290	2.019	1.724	1.522
16.0 "	0.1239	0.0002	0.08435	2.778	2.350	2.041

SOLUBILITY OF CARBON DIOXIDE IN PURE ETHYL ALCOHOL AND IN ETHYL
ALCOHOL CONTAINING INCREASING AMOUNTS OF SALTS AT 20°
(Kosakewitsch, 1929)

Gm. mols. salt per 100 gm. mols. C ₂ H ₅ OH	Gm. mols. CO ₂ per 100 Gm. mols. C ₂ H ₅ OH (reduced to 760mm. pressure) in C ₂ H ₅ OH solution of:			
	LiBr	LiCl	LiI	NaI
0.0 (= pure C ₂ H ₅ OH)	0.768	0.768	0.768	0.768
1.0	0.712	0.720	0.702	0.720
2.0	0.670	0.682	0.650	0.675
4.0	0.602	0.617	0.554	0.601
6.0	0.547	0.564	0.476	0.550
8.0	...	0.514	0.421	0.517
10.0	...	0.470	0.388	...
12.0	...	0.432	...	...

SOLUBILITY OF CARBON DIOXIDE IN PURE METHYL ALCOHOL AND IN METHYL ALCOHOL CONTAINING INCREASING AMOUNTS OF SALTS AT 15°
(Kosakewitsch, 1929)

Gm. mols. salt per 100 gm. mols. CH ₃ OH	Gm. mols. CO ₂ per 100 Gm. mols. CH ₃ OH (reduced to 760mm. pressure) in CH ₃ OH solution of:			
	LiBr	LiCl	LiI	NaI
0.0 (= pure CH ₃ OH)	0.825	0.825	0.825	0.825
1.0	0.764	0.762	0.756	0.758
2.0	0.710	0.708	0.693	0.698
4.0	0.618	0.611	...	0.598
6.0	0.540	0.526	...	0.518
8.0	0.470	0.450	...	0.457
10.0	0.410	...	...	...

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS ORGANIC SOLVENTS
(Just, 1901)

Results are given in terms of the Ostwald coefficient *l*. Numbers in parentheses indicate the tables (following) in which additional data is given for the solvent. See other tables for solvents not listed here.

Solvent	125	120	115	Solvent	125	120	115
Water	0.8256	....	....	Benzene (3,7)	2.425	2.540	2.710
Glycerol	0.0302	....	....	Amyl bromide	2.455	2.638	2.803
Carbon Disulfide (3,8)	0.8699	0.8888	0.9446	Nitrobenzene (3,7)	2.456	2.655	2.845
Iodobenzene	1.301	1.371	1.440	Propyl Alcohol (7)	2.498	...	...
Aniline (2,3)	1.324	1.434	1.531	Carvol	2.498	2.690	2.914
o-Toluidine	1.381	1.473	1.539	Ethyl Alcohol (97%)	2.706	2.923	3.130
m-Toluidine	1.436	1.581	1.730	Benzaldehyde (2)	2.841	3.057	3.304
Eugenol	1.539	1.653	1.762	Amyl chloride	2.910	3.127	3.363
Benzene Trichloride	1.643	....	....	Isobutyl chloride	3.105	3.388	3.659
Cumol	1.782	1.879	1.978	Chloroform (2,3,9)	3.430	3.681	3.956
Carvone	1.802	1.921	2.030	Butyric Acid	3.478	3.767	4.084
Dichlorhydrine	1.810	1.917	2.034	Ethylene Chloride	3.525	3.795	4.061
Amyl Alcohol	1.831	1.941	2.058	Pyridine (2,3)	3.656	3.862	4.291
Bromobenzene (7)	1.842	1.964	2.092	Methyl Alcohol (2,4,7)	3.837	4.205	4.606
Isobutyl Alcohol	1.849	1.964	2.088	Amyl Formate	4.026	4.329	4.646
Benzylchloride	1.938	2.072	2.180	Propionic Acid	4.078	4.407	4.787
Metoxylol	2.090	2.216	2.346	Amyl Acetate (2)	4.119	4.411	4.850
Ethylenebromide (2)	2.157	2.294	2.424	Acetic Acid (2)	4.679	5.129	5.614
Chlorobenzene (3,7)	2.265	2.420	2.581	Isobutyl Acetate	4.691	4.968	...
Carbon tetrachloride (3)	2.294*	2.502	2.603	Acetic Anhydride	5.206	5.720	6.218
Propylenebromide	2.301	2.453	2.586	Acetone (2,3,4,6)	6.295	...	...
Toluene (3,7)	2.305	2.426	2.557	Methyl Acetate (3,4)	6.494	...	...

*Horluhi (1928, 1931) found 2.668 at 1 atm. total pressure.

Table No. 2 Results of Kunerth, 1922

In many cases these data are in only fair agreement with those of other authors.

The CO₂ and solvent were measured at the same temperature and barometric pressure. The CO₂ was saturated with the vapor of the solvent before the solubility determination was made and thus no allowance for the vapor pressure of the solvent was necessary. The CO₂ was prepared by heating NaHCO₃ and passing the gas over CaCl₂ to remove H₂O.

Note that the results in H₂O are lower than those of other workers (p. 459, 460).

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN VARIOUS ORGANIC SOLVENTS—Cont.

Solvent	Oetwald Coefficient cc. CO ₂ dissolved per 1 cc. of solvent									
	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°
Water	..	0.900	0.872	0.834	0.800	0.765	0.729	0.693	0.656	..
Acetone	..	6.98	6.76	6.55	6.22	5.88	5.49	5.08	4.66	..
Acetic acid	5.40	5.23	5.07	4.91	4.73	4.57	4.41	4.25	4.12	4.00
Pyridine	3.95	3.85	3.75	3.63	3.53	3.45	3.33	3.25	3.13	3.03
Methyl alcohol	3.63	3.57	3.51	3.44	3.37	3.28	3.19	3.09	2.97	..
Ethyl "	2.95	2.87	2.80	2.73	2.66	2.58	2.48	2.41	2.51	..
Benzaldehyde	3.06	2.98	2.90	2.80	2.73	2.66	2.58	2.52	2.46	2.39
Aniline	..	1.38	1.35	1.32	1.29	1.25	1.22	1.21	1.19	1.17
Amyl acetate	4.79	4.65	4.55	4.44	4.35	4.29	4.14	4.10	4.02	..
Ethylene bromide	2.32	2.27	2.22	2.16	2.12	2.07	2.03	1.97	1.92	1.86
Iso amyl alcohol	..	1.91	1.88	1.85	1.81	1.76	1.72	1.69	1.67	..
Chloroform	3.83	3.71	3.60	3.50	3.39	3.26	3.11	2.94	2.81	2.68
Cyclo hexanol	..	...	...	...	0.671*	...	...	...	...	..

*Cauquil, 1927.

Table No. 3
Results of Gjaldbaek, 1953 and Gjaldbaek and Anderson, 1954

Solvent	R_{25}	Solvent	R_{25}
Toluene	2.21	Pyridine	3.36
Chloroform	3.59	Carbon tetrachloride	2.47
Chlorobenzene	2.16	n-heptane	1.84 ^a
1,2 Dibromethane	2.00	Benzyl cyanide	2.05
Carbon disulfide	1.21	Acetone	6.45
n-perfluoroheptane	2.09	Propionitrile	5.39
dimethyl formamide	4.4*	Nitrobenzene	2.20
n-propyl acetate	4.82	Cyclohexane	1.58
Aniline	1.20	Benzene	2.43 ^b
Methyl acetate	6.43		

*E. I. DuPont Co., 1955

^a $R_{20.5^\circ} = 1.98$; $R_{34.5^\circ} = 1.62$ ^b $R_{20.5^\circ} = 2.62$; $R_{29.7^\circ} = 2.33$; $R_{34.2^\circ} = 2.17$

Table No. 4
SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT LOW
TEMPERATURES AND PRESSURES
(Stern, 1912-13)

Very accurate determinations with an elaborate apparatus. The results are expressed in terms of K' = the number of cc. of CO₂, reduced to 0°, absorbed at the indicated pressure by 1 gram of liquid. This number differs from the Bunsen absorption coefficient only by a constant factor which is the density d of the liquid. Therefore Bunsen coef. $\beta = K'd$. The results are also expressed in terms of the Oetwald solubility expression l .

**SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT LOW
TEMPERATURES AND PRESSURES--Cont.**

t°	Pressure in m.m. Hg.	Solvent, CH ₃ OH $d_{-78}^4 = 0.884$ $d_{-59}^4 = 0.866$		Solvent, (CH ₃) ₂ CO $d_{-78}^4 = 0.900$ $d_{-59}^4 = 0.879$		Solvent, CH ₃ CO ₂ .C ₂ H ₅ $d_{-78}^4 = 1.017$ $d_{-59}^4 = 0.0994$		Solvent, CH ₃ CO ₂ CH ₃ $d_{-78}^4 = 1.056$ $d_{-59}^4 = 1.032$	
		K'		K'		K'		K'	
		l		l		l		l	
-78	50	194	120.5	311	196.6	250.2	177.5	304.9	224.1
"	100	195	119.6	322	198.1	255.6	177.1	315	224.3
"	200	202.9	120.1	344.5	201.5	271.8	179.2	337.4	223.1
"	400	221.5	122.2	400	208.8	310.9	183.2	389.3	255.6
"	700	260	126.8	545.5	...	...	...	...	...
-59	100	63	42.5	97.8	67.2	85.3	65.6	94.3	75.8
"	200	64.2	42.7	101.2	68	86.3	65.3	98.4 ⁵	77.1
"	400	66.3	43.1	106.6	72.8	91.6	66.7	103.6	77.6
"	700	69	43.35	118.8	72.8	101.5	69.7	112.9	79

Table No. 5
The System CO₂-Ether
(Thiel and Schulte, 1920)

The authors also give results for the composition of the vapor phase, and in some cases the liquid phase, in systems composed of carbon dioxide and each of the following compounds: ethyl chloride, sulfur dioxide, methyl ether, chlorine, and hydrogen sulfide. For data at high pressures, see table No. 7.

Solubility of Solid CO₂ in Ether

t°	Mol. percent Ether in the		t°	Mol. percent in sat. sol.	
	Vapor Phase	Liquid Phase		Ether	CO ₂
-78.6	0.065	52.6	-83.5	54.6	45.4
-63.7	0.25	72.9	-92.5	63.4	36.6
-23.8	6.1	93.3	-98.0	69.4	30.6
0	23.8	97.7			
+15	45.4	98.6			

Results in Terms of the Ostwald Solubility Expression L.
(Christoff, 1912)

$$l_0 = 7.330$$

$$l_{10} = 6.044$$

$$l_{15} = 5.465$$

Table No. 6

**SOLUBILITY OF CARBON DIOXIDE IN ACETONE
(Felsing and Durban, 1926)**

t°	cc CO ₂ (at 0° & 760mm.) dissolved by 1.0 gm. CH ₃ .CO.CH ₃ at p.p. 760mm.		t°	cc CO ₂ (at 0° & 760mm.) dissolved by 1.0 gm. CH ₃ .CO.CH ₃ at p.p. 760mm.	
-73.1	313		-13.6	20.2	
-60.1	133		-2.5	13.9	
-45.1	62.7		+20.0	7.97	
-29.2	33.1				

C CARBON

Data for the reciprocal solubility of CO_2 (also air, SO_2 , NH_3 , and HCl) and the vapors of ethyl ether, methyl alcohol, acetone and chloroform, as determined by measuring at 25° the change in pressure produced by adding a weighed amount of the volatile liquid to a given volume of carbon dioxide, are given by Mac Farlane and Wright, 1934.

Data for the adsorption of CO_2 by p azoxyphenetol at temperatures below and above its melting point, show that no adsorption or solution occurs while the material is in the solid (unmelted) condition, but after the first melting, absorption takes place and as soon as the isotropic liquid phase is reached, a second very well-marked increase in absorption is observed. After this, expansion and decrease of solubility proceed regularly with rise of temp. (Homfray, 1910).

0

Table No. 7

Data at High Pressures

SOLUBILITY OF CARBON DIOXIDE IN METHANOL AT HIGH PRESSURES (Krichevskii and Lebedeva, 1947)

Cm^3 of carbon dioxide measured at 0° , 760 mm dissolves in 1 gm. of methanol.

Pressure atm.	0°	25°	49.8°	75°
6.8	59.5	29.9	19.5	12.8
10.7	94.9	49.3	32.1	22.3
16.5	174	82.5	51.8	35.5
22.3	270	118	71.9	48.6
30.0		197	112	71.5
39.7		287	161	103
49.4			228	140
55.2			269	...
59.4				181
68.8				234

SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT HIGH PRESSURES (Sander, 1911-12)

(See Note at end of tables, p. 483)

Pressure in Kg. per Sq. Cm.	Cc. of CO_2 (Reduced to 1 Kg per Sq. Cm.) Dissolved at the Temp. and Pressure of Experiment by 1 cc. of Sat. Solution in:								
	$\text{C}_2\text{H}_5\text{OH}$ (0.093 cc.)	$\text{C}_3\text{H}_7\text{OH}$ (0.103 cc.)	$(\text{C}_2\text{H}_5)_2\text{O}$ (0.131 cc.)	$\text{CH}_3\text{COOC}_2\text{H}_5$ (0.155 cc.)	C_6H_6^* (0.08 cc.)	$\text{C}_6\text{H}_5\text{Cl}$ (0.106 cc.)	$\text{C}_6\text{H}_5\text{Br}$ (0.113 cc.)	$\text{C}_6\text{H}_5\text{NO}_2$ (0.164 cc.)	$\text{C}_6\text{H}_5\text{CH}_3$ (0.114 cc.)
Results at 20°									
20	...	56.16	...	...	71.16	62.61	50.83	57.12	57.91
30	104.8	86.62	...	188.2	125.3	95.22	82.29	92.50	103.3
40	149.7	122.1	...	227.9	192.4	137.3	121.1	115.9	155.9
50	188.8	174.6	...	...	264.3	187.5	160	155.9	235.8
Results at 35°									
20	...	40	...	...	48.65	46.66	43.38	44.48	49.6
40	113.1	98.16	...	188.4	138.3	101.5	90.43	94.39	118.8
60	173	159.9	241.3	219.8	243.1	168.3	146	145.1	192.1
80	...	269.6	...	...	...	...	233.9	227	...

*See also p. 487

SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT HIGH PRESSURES--Cont.

Pressure in Kg. per Sq. Cm.	Cc. of CO ₂ (Reduced to 1 Kg per Sq. Cm.) Dissolved at the Temp. and Pressure of Experiment by 1 cc. of Sat. Solution in:									
	C ₂ H ₅ OH (0.093 cc.)	C ₂ H ₇ OH (0.103 cc.)	(C ₂ H ₅) ₂ O (0.131 cc.)	CH ₃ COOC ₂ H ₅ (0.155 cc.)	C ₆ H ₆ * (0.08 cc.)	C ₆ H ₅ Cl (0.106 cc.)	C ₆ H ₅ Br (0.113 cc.)	C ₆ H ₅ NO ₂ (0.164 cc.)	C ₆ H ₅ CH ₃ (0.114 cc.)	
Results at 60°										
20	...	24.73	...	...	34.57	35.86	30.58	31.38	...	
40	72.82	64.65	...	140.5	88.71	73.69	62.64	52.26	78.67	
60	122.5	111.5	195.4	186.7	156.6	118.1	98.73	72.15	128.1	
80	167.9	159.2	221.4	223.4	215	149.3	131.4	85.03	171.9	
100	195.7	213.9	248.7	...	284.4	...	169.7	...	210	
Results at 100°										
30	...	...	...	...	...	33.65	30.56	41.09	...	28.68
40	...	26.5	...	80.70	46.52	48.16	41.49	50.36	49.25	
60	66.05	74.51	101	132	91.27	77.24	72.64	70.85	85.98	
80	112.2	107.7	142.8	162.3	155.8	103	92.86	86.86	117.6	
100	145.7	144.7	175.4	191.5	212.9	121.5	118	...	149	
120	174.6	175.4	...	...	258.2	140.7	140.7	...	171.8	
130	182.6	...	...	...	...	146.8	...	...	178.2	

*See also p. 487

The figures in parentheses immediately below the formulas of the solvents in the above table, show the volumes of solvent used for the series of determinations in each case. The volumes of CO₂ varied from about 55 to 77 cc. in the several cases. The increasing content of CO₂ in the solvents at increasing pressures caused a considerable increase in volume of the solvent. This was determined and the proper calculation of the readings to the saturated solution were made. All necessary figures to show the extent of the applicability of Henry's Law in the present case, are given.

Data for the solubility of carbon dioxide in mixtures of acetic acid and carbon tetrachloride and of ethylene chloride and carbon disulfide are given by Christoff, 1905.

The solubility of CO₂ in various mixtures of mono-, di- and tri-ethylamines was determined by Shneerson and Leibush, 1949. Data in aqueous solutions of mono and tri-ethanolamine from 25°-75° up to 40 atmospheres pressure are given by Lyndkovskaya and Leibush (1949).

Table No. 8

SOLUBILITY OF CARBON DIOXIDE IN CARBON DISULFIDE
(Woukoloff, 1889)

The author gives data for the solubility of carbon dioxide in carbon disulfide at two pressures of carbon dioxide at each of three temperatures. The data below was extrapolated to 760 mm of carbon dioxide and converted to a total pressure by adding the vapor pressure of carbon disulfide at each temperature. α = cc of CO₂ (measured at 0°, 760 mm) dissolved in 1 cc of CS₂.

Temp.	α at 760 mm CO ₂	α at 760 mm Total Pressure	Temp.	α at 760 mm CO ₂	α at 760 mm Total Pressure
0°	1.51	1.30	20°	1.25	0.90
5°	1.44	1.20	25°	1.19	0.81
10°	1.38	1.09	30°	1.13	0.72
15°	1.32	0.99			

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SOLUBILITY OF CARBON DIOXIDE IN CHLOROFORM AT 13° (Table No. 9) (Woukoloff, 1889a)

The results are given in terms of the "coefficient of dissolution" which is probably the Bunsen adsorption coefficient. The values were interpolated from the data given by the author. The solubility is strictly proportional to the pressure.

Pressure mm.	α	Pressure mm.	α
50.0	0.279	450.0	2.591
100.0	0.565	500.0	2.881
150.0	0.859	550.0	3.168
200.0	1.145	600.0	3.454
250.0	1.436	650.0	3.747
300.0	1.716	700.0	4.046
350.0	2.069	750.0	4.360
400.0	2.305	760.0	4.425

By means of density determinations of co-existing gaseous and liquid carbon dioxide, both in the presence and absence of water, it was estimated that the solubility of H_2O in liquid CO_2 is less than 0.05 percent by weight. (Lowery and Erickson, 1927).

Vapor pressure - temperature data are given for the following systems:

CO_2 + Hydrogen Sulfide	(Klemenc and Bankowski, 1932)
" + Methyl Alcohol	(Baume and Perrot, 1911, 1914)
" + Methyl Ether	(" " ")
" + as. o Xylidine	(Scheffer and Smittenberg, 1932)
" + o Nitro Phenol	(" " " 1933)
" + o Chloro Nitro Phenol	(Scheffer and Smittenberg, 1933)
" + <u>m</u> " " " "	(" " " ")

Determinations of the melting points, defining the liquid areas in the system Carbon Dioxide, Urea, and Ammonia, are given by Davis and Black, 1931.

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF NON-ELECTROLYTES

(Results of Usher, 1910 at 20°)

Results in terms of the Bunsen Absorption Coefficient β

Aqueous Solution of:	Gm. Mols. per Liter	d_{20} of Aq. Sol.	Absorption Coef. β .
Water Alone	...	....	0.877
Dextrose	0.5	1.0328	0.792
Mannitol	0.5	1.0303	0.782
Glycine	0.5	1.0141	0.843
Pyrogallol	0.5	1.0172	0.853
Quinol	0.5	1.0095	0.887
Resorcinol	0.5	1.0096	0.901
Catechol	0.5	1.0107	0.868
Urethan	0.5	1.0037	0.860
Carbamide*	0.5	1.0072	0.864
Thiocarbamide	0.5	1.0092	0.859
Antipyrine	0.5	1.0132	0.859
Acetamide	0.5	1.0005	0.879
Acetic Acid	0.5	1.0026	0.868
n Propyl Alcohol	0.5	0.9939	0.869

*also see the data of Kiss, Lajtai and Thury, p. 487.

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF
NON-ELECTROLYTES--Cont.

Results in other solutions:

Solvent	t°	Wt. % organic compd. in solvent	l	β	Author	
None	25	0	0.823	0.754	Kobe and Mason 1946	0
Glycerol (see also p. 486)	25	40	0.592	0.542		
Ethylene Glycol	25	60	0.627	0.574		
"	25	40	0.654	0.599		
"	25	20	0.726	0.666		
Dioxane	25	60	1.523	1.395		
Dihydroxy ethyl ether	25	60	0.633	0.579	von Hammel, 1915	
Tetrahydrofurfural alcohol	25	75	1.113	1.020		
Chloral hydrate	15	17.7	0.935	0.885		
		31.6	0.848	0.803		
		38.3	0.825	0.781		
		49.8	0.802	0.760		
		57.1	0.808	0.765		
		68.8	0.842	0.797		
		79.4	0.953	0.903		

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF SUGARS AT 15°
(Showalter and Ferguson, 1936)

Kahlbaum's levulose "Aus Inulin" was used in these experiments. The authors also give results for the solubility of carbon dioxide in aqueous solutions of mixtures of Alcohol and Dextrose and Alcohol and Sucrose. They used a new type of solubility apparatus.

Data for the solubility of CO₂ in Sugar solutions and its combination with amino acids are given by Majer, 1928.

Results for Aq. Solutions of:

Sucrose			Dextrose (D Glucose)		
Wt. percent C ₁₂ H ₂₂ O ₁₁ in solvent	Bunsen Abs. coef. β of CO ₂		Wt. percent C ₆ H ₁₂ O ₆ in solvent	Bunsen Abs. coef. β of CO ₂	
8.4	0.945		4.5	0.9714	
15.7	0.8952		9.25	0.9284	
25.5	0.8026		11.2	0.8986	
Results of Usher, 1910 at 20°: moles C ₁₂ H ₂₂ O ₁₁ per liter			15.0	0.8526	
			21.9	0.7772	
			22.4	0.7636	
			26.9	0.7157	
			27.9	0.7050	
	d ₂₀	β			
0.125	1.0152	0.846			
0.25	1.0313	0.815			
0.50	1.0637	0.756			
1	1.1281	0.649			

(Cont.)

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF SUGARS AT 15°--Cont.

Results for Aq. Solutions of Levulose (D Fructose)
(Showalter and Ferguson, 1936)

Wt. percent $C_6H_{12}O_6$ in solvent	Bunsen Abs. coef. β of CO_2
6.2	0.9529
10.7	0.9061
12.0	0.8768
13.6	0.8670
14.1	0.8676
21.2	0.7866
23.1	0.7452

SOLUBILITY OF CO_2 IN GLYCEROL SOLUTIONS

Results of Kiss, Lajtai and Thury, 1937

Mols. glycerol per liter	Gm. mols. CO_2 dissolved per liter saturated sol. at:			Ostwald Sol. Expression l for CO_2 dissolved at:		
	0.05°	12.5°	25°	0.05°	12.5°	25°
2.0 $C_3H_8O_3$	0.05086	0.03690	0.02723	1.140	0.8653	0.6664
4.0 "	0.03570	0.02696	0.02110	0.8006	0.6322	0.5164
6.0 "	0.02776	0.02214	0.01850	0.6225	0.5192	0.4528
8.0 "	0.02202	0.01865	0.01570	0.4938	0.4374	0.3842

Results of von Hammel, 1915 at 15°.

Gms. $(CH_2OH)_2CHOH$ per 100 Gms. Aq. Sol.	β_{15}	l_{15}	Gms. $(CH_2OH)_2CHOH$ per 100 Gms. Aq. Sol.	β_{15}	l_{15}
0	1.008	1.064	62.14	0.511	0.540
26.11	0.785	0.829	77.75	0.430	0.454
43.72	0.639	0.675	90.74	0.404	0.427
			99.26	0.410	0.438

Results of Kobe and Mason, 1946 at 25°

The value for β_{25} in 40 wt.% glycerol is $0.542 \cdot l_{25} = 0.592$.

SOLUBILITY OF CO₂ IN AQUEOUS ACETONE AND UREA SOLUTIONS
(Kiss, Lajtai and Thury, 1937)

Solvent: Moles per liter	Gm. mols. CO ₂ dissolved per liter saturated sol. at:			Ostwald Sol. Expression <i>l</i> for CO ₂ dissolved at:		
	0.05°	12.5°	25°	0.05°	12.5°	25°
Results for aq. solutions of Acetone						
2.0 CH ₃ COCH ₃	0.06751	0.04790	0.03562	1.514	1.123	0.8718
4.0 "	0.06510	0.04984	0.03990	1.460	1.169	0.9765
6.0 "	0.07194	0.05809	0.04825	1.613	1.362	1.181
8.0 "	0.09596	0.08050	0.06987	2.152	1.639	1.710
10.0 "	0.1505	0.1308	0.1135	3.375	3.067	2.778
12.0 "	0.2595	0.2158	0.1826	5.820	5.062	4.469
Results for aq. solutions of Urea (Carbamide)						
2.0 NH ₂ CONH ₂	0.06665	0.04571	0.03290	1.495	1.072	0.8052
4.0 "	0.06061	0.04326	0.03230	1.359	1.015	0.7905
6.0 "	0.05560	0.04131	0.03190	1.247	0.9687	0.7807
8.0 "	.....	0.03819	0.03060	...	0.8956	0.7589

Determinations by Northrop, 1929 show that the solubility of carbon dioxide in Collodion is proportional to the pressure between 0 and 800 mm. Hg at room temperature.

SOLUBILITY OF CARBON DIOXIDE IN BENZENE
(Wan and Dodge, 1940)

The solubility of carbon dioxide in benzene was determined at various temperatures and pressures in an all metal cylinder immersed in an oil bath. The temperature was carefully controlled, and benzene of boiling point 79.9° - 80.1° was used. The authors give graphs showing the mole fraction of carbon dioxide in the liquid and in the vapor, and the Henry's law constants are tabulated. The solubilities in terms of grams of carbon dioxide per gram of benzene were calculated from the author's graphs. The data do not agree with those of Sandor (p. 482, 3).

$$K = \frac{\text{Total pressure} \times \text{mole fraction CO}_2 \text{ in vapor}}{\text{Mole Fraction CO}_2 \text{ in Liquid}}$$

Mole Fraction CO ₂ in Liquid	Henry's law constants (K)			
	30°	40°	50°	60°
0.10	1240	1420	1670	1850
.20	1230	1430	1650	1918
.30	1208	1440	1605	1940
.40	1190	1395	1605	1935
.50	1169	1360	1588	1910
.60	1102	1303	1535	1840
.70	1045	1255	1492	1742

(Cont.)

C CARBON

SOLUBILITY OF CARBON DIOXIDE IN BENZENE--Cont.

A = Grams carbon dioxide dissolved per gram of benzene

B = Mol % carbon dioxide

Total Pressure Lbs. per sq. inch	30°		40°		50°		60°	
	A	B	A	B	A	B	A	B
100	0.048	7.8	0.039	6.5	0.035	5.8	0.030	5.0
200	.108	16.0	.090	13.7	.073	11.5	.063	10.0
300	.183	24.5	.145	20.5	.120	17.5	.093	15.0
400	.275	32.8	.214	27.3	.175	23.7	.141	20.0
500	.392	41.0	.298	34.6	.247	30.5	.188	25.0
600	.581	50.5	.416	42.5	.322	36.7	.242	30.0
700	.960	63.0	.587	51.0	.422	42.8	.310	35.5
800	1.91	77.2	.846	60.0	.552	49.5	.383	40.5
900	3.91	87.4	1.315	70.0	.719	56.5	.471	45.5
1000	15.55	96.5	2.500	81.6	1.049	65.0	.598	51.5
1100					1.520	73.0	.772	57.8
1200					3.19	85.0	.845	66.0
1300							1.762	75.8
1400							2.328	88.5

SOLUBILITY OF CO₂ IN TOLUENE AT LOW TEMPERATURES (Williams, 1952)

t°	cc CO ₂ (S.T.P.) per gm. toluene at 760mm.	t°	cc CO ₂ (S.T.P.) per gm. toluene at 760mm.
0	3.81	-50	11.04
-10	4.62	-60	15.96
-20	5.60	-70	20.46
-30	6.90	-80	22.47
-40	8.80		

DISTRIBUTION OF CARBON DIOXIDE BETWEEN HYDROCARBONS AND SALT SOLUTION AT 40° (McCay, Seeley, and Gardner, 1941)

The solubility in each hydrocarbon and in 5% NaCl solution was determined and the distribution ratios between the organic and aqueous phases were calculated at each pressure. (Solubilities at 5 atm. intervals are also given).

Gms. CO₂ per gm. of Hydrocarbon or gm. of 5% NaCl solution

Pressure Atm. (absolute)	Pentane		Benzene		Decahydro- naphthalene	
	C ₅ H ₁₂	5% NaCl	C ₆ H ₆	5% NaCl	C ₁₀ H ₁₈	5% NaCl
10	0.1430	0.00685	0.0322	0.00730	0.0280	0.0100
20	.2480	.00985	.0969	.01298	.0600	.0160
30	.3370	.01310	.1932	.01651	.0900	.0219
40	.4500	.01725	.3220	.01932	.1200	.0275
50	.6420	.02130	.5470	.02402	.1520	.0325
60			1.1910	.03415	.2040	.0368
70					.3020	.0400

DISTRIBUTION OF CARBON DIOXIDE BETWEEN
HYDROCARBONS AND SALT SOLUTION AT 40°--Cont.

Pressure Atm. (absolute)	Gms. CO ₂ per gm. of Hydrocarbon or gm. of 5% NaCl solution			
	Cyclohexane		Hexadecane	
	C ₆ H ₁₂	5% NaCl	C ₁₆ H ₃₄	5% NaCl
10	0.0652	0.0110	0.0800	0.0094
20	.1213	.0154	.1580	.0150
30	.1895	.0179	.2260	.0188
40	.2395	.0206	.2810	.0215
50	.2900	.0236	.3330	.0245
60	.3500	.0266	.3930	.0283
70	.4130	.0284	.4700	.0329
80	.5310	.0272	.6900	.0290

SOLUBILITY OF CARBON DIOXIDE IN NORMAL PARAFFIN HYDROCARBONS
(Stewart and Nielson, 1954)

60° F.		90° F.		60° F.		90° F.	
Pressure (p.s.i.a.)	Mole % CO ₂	Pressure (p.s.i.a.)	Mole % CO ₂	Pressure (p.s.i.a.)	Mole % CO ₂	Pressure (p.s.i.a.)	Mole % CO ₂
n-Octane				n-Tetradecane			
166	12.9	154	9.9	183	17.1	120	8.7
470	44.6	570	34.3	425	39.1	547	38.4
572	64.0	755	61.6	661	63.9	918	65.7
619	73.1	861	76.6	700	69.9	1062	96.5
637	76.5	901	82.1	735	81.0	1062*	83.4
695	93.3	998	93.5	735*	94.5		
		1009	95.9				
n-Decane				n-Hexadecane			
166	13.5	120	7.6	146	14.1	132	9.7
415	38.0	466	31.1	420	38.8	465	31.6
586	57.2	638	44.8	614	55.5	814	54.7
626	66.4	820	63.7	710	68.0	1021	71.4
694	87.4	942	80.6	737	71.2	1064	74.8
725	96.3	959	83.7	737*	98.12	1080	98.95
		1022	95.3			1080*	75.3
n-Dodecane				*Two liquid phases.			
157	12.9	130	9.0				
365	33.2	497	34.1				
507	47.4	729	51.3				
668	70.9	983	79.2				
712	90.3	1020	89.0				
723	95.5	1033	92.5				

Three-phase equilibrium in the following systems were determined by Meldrum and Nielson, 1955.

CO₂ - propane - n-hexadecane
 CO₂ - n-decane - "
 CO₂ - " - stripped crude oil
 CO₂ - propane - " " "

C CARBON

SOLUBILITY OF CO₂ IN PARAFFIN

Data for the solubility of CO₂ in crude paraffin (M.W. approx. 345) are given by Peter and Weinert (1955) as follows:

t°	106	203	300
Moles CO ₂ per Kg. paraffin per Kp/cm ² pressure	0.0270	0.0201	0.0184

Ridenour, Weatherford Jr., and Capell, 1954 found that the solubility of CO₂ in molten paraffin wax (mp 50.4°C, M.W. 350) increased with increasing partial pressure of CO₂ at 72.2°:

pp CO ₂ mm.	872.2°
257	0.471
752	0.548

The absorption coefficient β of CO₂ in Russian petroleum was found by Gniewosz and Walfisz (1887) to be 1.17 at 20° and 1.31 at 10°.

The solubility of carbon dioxide in purified white mineral oil of $d_{27} = 0.868$, viscosity (Saybolt) 285 at 37.8°C and f. pt. of about -37°, was found to be 0.841 ± 0.011 cc. CO₂ (at 0° and 760 mm. pressure per 1.0 cc. of oil (neglecting the change in volume of the oil) under one atmosphere pressure of the gas (neglecting the partial pressure of water and oil vapor over the oil). Determinations were also made of the rate of diffusion of CO₂ from the oil to the air. (Kubie, 1927).

SOLUBILITY OF CARBON DIOXIDE IN FATS (Schaffer and Haller, 1943)

Ml of gas (0°, 760 mm) per 1000 ml of fat

	40°	60°
Butter oil	109.5	91.0
Cottonseed oil	87.6	..
Lard	100.3	..

Data for the absorption of CO₂ by rubber and carbon are given by Reyhler (1910).

100 cc. of rubber saturated with carbon dioxide at 21°, dissolve 00 cc. CO₂ (0° and 760 mm.). The determination was made by pumping out the gas with a Topley pump and measuring it over mercury. Results for the effect of pressure and temperature upon the solubility are also given. (Venable and Fuwa, 1922).

The pressure - volume - composition relationships for the liquid - vapor equilibria in the systems carbon dioxide - ethane, carbon dioxide - propane, carbon dioxide - butane, and carbon dioxide - pentane have been determined by Poettman and Katz (1945) from room temperature to the critical temperature.

Liquid - vapor equilibrium data in the system CO₂ + n-butane from 100° F to 460° F at pressures up to 10,000 lbs/sq. in. are given by Olds, Reamer, Sage, and Lacey, 1941.

At 170° and 50 atmospheres pressure, 2.9 cc of carbon dioxide (measured at 0°, 1 atm.) dissolve in 1 gm. of polystyrene. (Newitt and Weale, 1948).

The liquid - vapor region, critical locus, and 3-phase region involving solid CO_2 of the system CO_2 - methane were studied by Donnelly and Katz, 1954.

SOLUBILITY OF CO_2 IN ACETYLENE AND ETHYLENE
(Clark and Din, 1950, 1953)

temp. °K	mole % CO_2 in	
	pure C_2H_4	pure C_2H_6
130	1.4	0.2
150	4.3	0.9
170	13.0	3.1
180	..	6.7

0

Melting points in the system CO_2 - C_2H_6 are also given.

MUTUAL SOLUBILITY OF LIQUID CARBON DIOXIDE AND VARIOUS ORGANIC COMPOUNDS
(Francis, 1954)

The author determined the general outline of 464 ternary systems involving liquid carbon dioxide. The method of analysis was inexact, and only a few points were obtained in each system, but the mass of comparative data allows many useful generalizations to be drawn. Tie-line data are not given. The following compounds from two liquid layers with liquid CO_2 , and the compositions of the layers have been estimated to ± 5 -10%. The author lists 127 additional compounds which were miscible with CO_2 .

X = wt.% CO_2 in organic phase.

Y = wt.% organic compound in CO_2 phase.

Compound	X	Y	Compound	X	Y
Acetamide	-	1	o-Chloroaniline	25	5
Aldol	31	11	m-Chloroaniline	23	1
Aluminum Chloride	-	0	β-Chloroethanol	40	10
Aniline	20	3	α-Chlorophthalene	15	1
O-Anisidine	20	1	p-Chlorophenol	25	8
Benzalacetone	40	5	2-Chloro-6-phenylphenol	20	1
Benzoic anhydride	20	3	α-Chloropropionic acid	52	26
Benzophenone	25	4	Cinnamaldehyde	20	4
Benzyl alcohol	26	8	Cinnamyl alcohol	20	5
Benzyl benzoate	40	10	o-Cresol	30	2
Bibenzyl	-	1	m-Cresol	20	4
Biphenyl	15	2	p-Cresol	30	2
Bright stock	15	0.5	Crystal oil	20	1
Bromine	8	2	Cyclohexanol	20	4
Bromoform	40	30	Decahydronaphthalene	42	22
Butyl phthalate	55	8	1 Decyl alcohol	30	1
Butyl stearate	55	3	2,4-Dichlorophenol	30	14
Calcium nitrate	-	0	N,N-Diethylaniline	45	17
Castor oil	15	1	Diethylene glycol	10	1
Chloral hydrate	-	2	Dimethylnaphthalenes	40	2
Chloroacetic acid	-	10	2,5-Dimethylpyrate	32	5

(Cont.)

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MUTUAL SOLUBILITY OF LIQUID CARBON DIOXIDE AND VARIOUS
ORGANIC COMPOUNDS--Cont.

Compound	X	Y	Compound	X	Y
2,4-Dinitrochlorobenzene	15	1	o-Nitrochlorobenzene	42	21
Diphenylamine	-	1	α-Nitronaphthalene	-	1
N,N.-Diphenylethylene- diamine	-	1	p-Nitrotoluene	56	20
Diphenylmethane	30	4	n-Octadecane	30	3
Dipropylene glycol	15	2	1-Octadecane	26	10
N-Ethylaniline	35	13	Oleic acid	22	2
Ethyl anthranilate	50	6	Oleum	6	0.1
0 N-Ethyl-N-benzyl-aniline	33	4	Olive oil	20	4
Ethylene glycol	7	0.2	Paraffin wax	-	1
2-Ethylhexanol	53	17	p-Phenetidine	12	1
p-Ethylphenol	8	1	Phenol	-	3
Ethyl phthalate	60	10	Phenylacetic acid	-	0
Eugenol	38	10	Phenylacetoneitrile	52	13
Formamide	10	0.5	4-phenyl-3-butene-2-one	40	5
Formanilide	10	0.5	Phenylcyclohexane	35	8
Fuel oil	42	18	Phenylethanol	15	3
Furfuryl alcohol	30	4	Phenylethanolamine	15	1
Glycerol	7	0.05	Phenyl ether	35	8
Heptyl alcohol	38	6.2	Phenyl phthalate	-	1
n-Hexadecane	38	8	Phenyl salicylate	38	9
Hydrocinnamaldehyde	55	17	Phthalyl chloride	33	4
o-Hydroxybiphenyl	-	1	Pinacol	23	2
β-Hydroxyethyl acetate	50	17	Piperonal	45	10
β-Hydroxypropionitrile	30	1	Propylene glycol	10	0.5
Iodine	-	0.2	Resorcinol	-	0.1
Lactic acid	8	0.5	Saligenin	-	0.1
Lauric acid	40	1	Silver nitrate	-	0
Lithium chloride	-	0	Succinonitrile	20	2
Lubricating oil	20	0.7	Sulfuric acid	6	0.1
Maleic anhydride	55	7.5	Tetrabromoethane	10	1
Mercuric chloride	20	5	n-Tetradecane	50	16
2-Methoxybiphenyl	20	5	Tetrahydrofurfuryl alcohol	20	3
α-Methoxynaphthalene	15	1	Tetrahydronaphthalene	41	12
n-Methylaniline	40	20	Thymol	41	9
p-Methylcyclohexanol	20	4	o-Toluidine	37	7
Methylene iodide	30	30	m-Toluidine	40	15
α-Methylnaphthalene	30	6	p-Toluidine	37	7
β-Methylnaphthalene	29	9	Transformer oil	14	2
Methyl phthalate	43	6	α, α, α, Trichlorotoluene	20	2
Monoacetin	10	1	Triethylene glycol	12	2
Naphthalene	-	2	Urea	-	0
α-Naphthalene	20	1	Water	6	0.104
o-Nitroanisole	35	2	3,5-Xylenol	-	1
o-Nitrobiphenyl	15	2	3,4-Xylidine	33	9

MUTUAL SOLUBILITY OF LIQUID CARBON DIOXIDE AND WATER
(Weibe, 1941)

At 22.6° the water-rich phase contains 5.78% CO₂ and the carbon dioxide-rich phase, 99.90% CO₂.

SOLUBILITY OF CARBON DIOXIDE IN LIQUID CHLORINE
(Krievé and Mason, 1956)

At 0°		At 25°		
mole% CO ₂	pp CO ₂ atm.	mole% CO ₂	pp CO ₂ atm.	
1.06	0.772	0.976	1.10	
1.593	1.10	1.42	1.50	
2.135	1.67	2.04	2.21	
2.983	2.29	2.98	3.03	
3.945	2.90	3.80	3.85	
4.950	3.59	4.74	4.80	
5.640	4.10	5.46	5.55	
6.582	4.78	6.43	6.54	0

SOLUBILITY OF SOLID CARBON DIOXIDE IN LIQUID OXYGEN AND NITROGEN
(Federova, 1940)

Temp. °K	Mole Fraction CO ₂ in Liquid:	
	Oxygen	Nitrogen
67.0°	1.77×10^{-6}	2.21×10^{-6}
78.4°	2.91×10^{-6}	3.47×10^{-6}
98°	5.61×10^{-6}	7.26×10^{-6}

SOLUBILITY OF CARBON DIOXIDE IN MIXTURES OF LIQUID OXYGEN + NITROGEN
(Ishkin and Burbo, 1939)

Vol.% O ₂ in Solvent	Temp. °K	cc. CO ₂ (0°, 760mm) per liter of Solution	Mole Fraction CO ₂ in Solution
99.6	90.0°	3.6	0.0000045
80.0	85.6°	2.8	.0000037
50.0	81.4°	2.1	.0000030
30.0	79.4°	1.85	.0000028
0.0	77.4°	1.49	.0000025

The equilibrium between solid carbon dioxide and air in the range -110° to -196° under varying pressures has been studied by Webster, 1952.

The solubility of solid CO₂ in helium and hydrogen at low temperatures was determined by Ewald, 1955.

The liquid-vapor equilibrium in the systems CO₂ + N₂ (0°), CO₂ + H₂ (25°) and CO₂ + CO (0°, 10°) are given in the form of diagrams by Abdulaev, 1939.

The pressure-composition diagram for the system CO₂ + H₂S is given by Stickel, 1945. Phase equilibria over the range 0-100°, 15-85 atm. are given by Bierlein and Kay, 1953.

P-V-T data at the critical point has been reported for the following systems:

CO ₂ - H ₂	Vershafield, 1899
CO ₂ - N ₂	Andrews, 1882
CO ₂ - O ₂	Keesom, 1903, 1903a, 1904

(Cont.)

C CARBON

P-V-T data at the critical point has been reported for the following systems--Continued:

CO ₂ - HCl	Ansdell, 1882
CO ₂ - N ₂ O	Caubet, 1904; Cook, 1953
CO ₂ - SO ₂	Caubet, 1902
CO ₂ - C ₂ H ₂	Kuenen, 1897
CO ₂ - C ₂ H ₆	Kuenen, 1897, 1897a; Kuenen and Robson, 1902
CO ₂ - CH ₃ Cl	Kuanen, 1892, 1897; Caubet, 1904
CO ₂ - C ₆ H ₅ NO ₂	Kohnstamm and Reeders, 1912
CO ₂ - Air	Caillietet, 1880
CO ₂ - I ₂	Caillietet and Colardeau, 1899; Villard, 1895, 1897
CO ₂ - <u>many</u> organics	Buchner, 1906

OS CARBON OXY SULFIDE COS

SOLUBILITY OF CARBON OXY SULFIDE IN WATER (Winkler, 1906)

t°	β	q	t°	β	q
0	1.333	0.356	20	0.561	0.147
5	1.056	0.281	25	0.468	0.122
10	0.836	0.221	30	0.403	0.104
15	0.677	0.179			

(For β and q see Carbon Dioxide, p. 459.)

SOLUBILITY OF CARBON OXY SULFIDE IN SEVERAL SOLVENTS

Solvent	t°	cc. COS per 100 cc. Solvent	Authority
Water	13.5	80	(Hempel, 1901)
"	20	54	(Stock and Kuss, 1917)
Alcohol	22	800	(" " " ")
Toluene	22	1500	(" " " ")
HCl solution of CuCl	13.5	20	(Hempel, 1901)
1 gm. KOH + 2 cc. H ₂ O + 2 cc. C ₂ H ₅ OH	13.5	7200	(" ")
Pyridine	..	4.4	(" ")
Nitrobenzene	..	12.0	(" ")

SOLUBILITY OF CARBON OXY SULFIDE IN OIL AT 32° (Avdeeva and Pitelina, 1947)

Note:

The solubility was measured in "solar oil" (petroleum) having the following physical properties: Molecular wt. 230; density 0.8768; initial boiling point 215°C; viscosity (Engler) 20° - 171, 50° - 128; flash pt. 108°. The data were read from graphs given by the authors, and the points lie on a straight line.

Vol.% COS in gas:	10	20	30	40	50	60
gms. COS per liter oil:	1.4	2.9	4.4	5.8	7.3	8.8

CALCIUM Ca

The melting point of the eutectic mixture in the system $\text{Ca} + \text{NH}_3$ is about -90° . (Birch and MacDonald, 1947).

The system $\text{Ca}-\text{CaCl}_2$ exhibits a miscibility gap. The eutectic compositions are at 1 mole% Ca, 767° and 99 mole% Ca, 825° . (Cubiceciotti and Thurmond, 1949; Eastman, Cubiceciotti, and Thurmond, 1950).

The solubility of Ca and CaO in fused CaCl_2 between 770° and 900° was studied by Kunitomi, 1950.

Determinations of the solubility of mixtures of metallic Ca and Na in melted mixtures of $\text{CaCl}_2 + \text{NaCl}$ at temperatures between 500° and 800° are given by Lorenz and Winzer, 1929.

The system $\text{Ca} + \text{MgCl}_2 \rightleftharpoons \text{Mg} + \text{CaCl}_2$ was studied at 860° and 1000° by Ostertag, 1955.

Data for the distribution of calcium between molten slags and iron saturated with carbon is given by Philbrook, Goldman, and Helzl, 1950.

CALCIUM ALUMINATES $x\text{CaO} \cdot y\text{Al}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

A10

THE SYSTEM $\text{CaO} - \text{Al}_2\text{O}_3 - \text{H}_2\text{O}$

Critical reviews of the data has been made by Steinnour, 1947, 1951 in which a total of 224 references are cited. A review is also given by d'Ans, 1953. The most detailed investigations have been those of Wells, Clarke and McMurdie, 1943 (21° , 90°), Peppler and Wells, 1954 (50° - 250°), and Bessy, 1938 (25°).

Wells, Clarke and McMurdie found that only three stable phases were present between 21° and 90° : $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$, and $\text{Ca}(\text{OH})_2$. $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$ and $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 13\text{H}_2\text{O}$ were found to exist metastably and to form a 1:1 compound.

The maximum stable solubility of Gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) at 21° is 0.02g Al_2O_3 /l. at 0.33 g. CaO/l. and at 90° is .11g Al_2O_3 /l. at 0.33g. CaO/l. (the maximum solubility of Al_2O_3 is 0.30g/l. at 120°), although the Gibbsite curve extends much further into the metastable region. At higher temperatures, Pepper and Wells showed that 1) Gibbsite was the stable crystalline phase below 150° ; boehmite above 150° ; 2) The only stable ternary compound up to 215° is $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$. At 250° the stable compound is $4\text{CaO} \cdot 3\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$; 3) All of the phases become less soluble at high temperatures; 4) The various metastable compounds exist at least to 90° .

The results of Bessey (1938) and Jones (1939, 1944) at 25° are in substantial agreement with these.

Travers and Seknoutka (1930), made a series of determinations of the solubilities of three crystalline forms of $3\text{CaO} \cdot \text{Al}_2\text{O}_3$, and $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, both hydrated and calcined, in water and in aqueous solutions of $\text{Ca}(\text{OH})_2$, KOH, CaSO_4 , CaCl_2 , NaCl and MgCl_2 , at room temperature and at the boiling point. It is probable however, that equilibrium was not reached since the mixtures were agitated only two hours. Assarsson, 1930, studied the system $\text{CaO} + \text{Al}_2\text{O}_3 + \text{H}_2\text{O}$ at 20° and allowed only 3 to 5 days for attainment of equilibrium, which was also hardly sufficient.

(Cont.)

THE SYSTEM $\text{CaO} - \text{Al}_2\text{O}_3 - \text{H}_2\text{O}$ —Cont.

He gives a diagram showing the approximate concentration areas corresponding to the solid phases $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 13.5\text{H}_2\text{O}$, $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 12.5\text{H}_2\text{O}$, $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$ and $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$. He also gives results for the solubility of the tetra calcium aluminate in aqueous solutions of calcium hydroxide. Nacker and Mosebach, 1936, agitated weighed amounts of $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ and CaCl_2 in 1000 cc. portions of water in an air thermostat at 30° for long periods and analyzed the saturated solutions for Al_2O_3 , CaO and CaCl_2 . The analytical results and microscopic examinations showed that the solid phase tended to approach the composition, $\text{Al}_2\text{O}_3 \cdot 3\text{CaO} \cdot \text{CaCl}_2 \cdot 10\text{H}_2\text{O}$. Additional data on calcium aluminates are given by Mille. Foret, 1931.

A10

SOLUBILITY OF $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ IN WATER

- | | |
|--|-------------------------------|
| (1) Peppler and Wells, 1954 | (5) Bessey, 1938 |
| (2) Wells, Clarke and McMurdie, 1943 | (6) Assarsson, 1930 |
| (3) Thorvaldson, Grace and Vigfusson, 1929 | (7) Travers and Zahabi, 1938 |
| (4) Brocard, 1948 | (8) Nacken and Mosebach, 1936 |

	[Peppler and Wells]			[Other Authors]
	Gms. per liter			
t°	CaO	Al ₂ O ₃	Total	Total (CaO + Al ₂ O ₃) Gms. per liter
15	...	...	...	0.297 (4)
20	...	...	...	0.24 (6)
21	0.208	0.131	0.339	0.246 (3), 0.32 (2), 0.316 (7)
23	...	...	...	0.19 (4)
25	...	...	...	0.29 (5)
30	...	...	...	0.308 (4), 0.37 (8)
40	...	...	...	0.20 (4), 0.268 (3)
50	0.223	0.133	0.356	...
60	0.246	0.123	0.369	...
90	0.306	0.190	0.496	...
120	0.300	0.170	0.470	...
150	0.235	0.204	0.439	...
200	0.175	0.148	0.323	...

The Quaternary system $\text{Al}_2\text{O}_3 - \text{Al}_2(\text{SO}_4)_3 - \text{CaO} - \text{CaSO}_4 - \text{H}_2\text{O}$ was studied by Jones 1939, 1944, using first the amorphous and then the crystalline aluminum oxide. The following stable phases were found at 25° : $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, $\text{Ca}(\text{OH})_2$, $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 32\text{H}_2\text{O}$ (incongruently soluble), $\text{Al}_2\text{O}_3 \cdot 3\text{CaO} \cdot 6\text{H}_2\text{O}$, and two series of solid solutions of the general composition $x\text{CaO} \cdot y\text{Al}_2\text{O}_3 \cdot z\text{CaSO}_4 \cdot \text{aq}$. The phase $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CaSO}_4 \cdot 12\text{H}_2\text{O}$ was found to be the limiting composition of one solid solution. Other possible metastable phases are the compound $\text{Al}_2\text{O}_3 \cdot 2\text{CaO} \cdot 8\text{H}_2\text{O}$ and another solid solution. Further data and reviews are given by d'Ans (1953) and Turrizani and Schippa, 1954. Steinour, 1951 discusses the system in detail.

Equilibrium in the system $\text{Al}_2\text{O}_3 + \text{CaO} + \text{CaCl}_2 + \text{H}_2\text{O}$. In connection with studies designed to throw light upon the binding power of Portland cement, Nacken and Mosebach, 1936 agitated for long periods of time, mixtures of weighed amounts of $3\text{CaO} \cdot \text{Al}_2\text{O}_3 + \text{CaCl}_2$ and of $3\text{CaO} \cdot \text{SiO}_2 + \text{CaCl}_2$ with 1000 gram portions of water at 30° . The saturated

SOLUBILITY OF $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ IN WATER--Cont.

solutions and residual solid phases were analyzed. These results and microscopic analyses showed that the solid phases tended to approach the composition $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CaCl}_2 \cdot 10\text{H}_2\text{O}$.

The quinary system $\text{CaO} - \text{Al}_2\text{O}_3 - \text{CaSO}_4 - \text{K}_2\text{O} - \text{H}_2\text{O}$ (1% KOH) at 25° was investigated by Jones (1944a). $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 32\text{H}_2\text{O}$ was the only stable quaternary compound found in the system. Kalousek, 1941 studied the system at 25° at very low K_2O concentrations.

The quinary system $\text{CaO} - \text{Al}_2\text{O}_3 - \text{CaSO}_4 - \text{Na}_2\text{O} - \text{H}_2\text{O}$ (1% NaOH) at 25° was investigated by Jones (1944b). The quaternary systems are included and the results are very similar to the potassium system (above). Kalousek, 1941 studied the system at various Na_2O concentrations at 25° . A10

A review of the systems involved in portland cement, including the substitution of Fe_2O_3 for Al_2O_3 has been made by Jones (1945).

The system $\text{CaO} + \text{Al}_2\text{O}_3 + \text{TiO}_2 + \text{H}_2\text{O}$ is discussed, and the known hydrates tabulated, by Bessey, (1938).

CALCIUM ARSENITES $x\text{CaO} \cdot y\text{As}_2\text{O}_3 \cdot z\text{H}_2\text{O}$

AsO

THE SYSTEM $\text{CaO} - \text{As}_2\text{O}_3 - \text{H}_2\text{O}$

(Story and Anderson, 1924; Guerin and Masson, 1949)

Data are given for the composition (As_2O_3 : CaO mole ratio) of the solid phase in equilibrium with various concentrations of As_2O_3 in solution at 0° , 25° and 99° , but the CaO concentration in the liquid is not reported. Guerin and Masson studied the system at 60° and found the same compounds.

0°	25°	60°	99°	
Gms. As_2O_3 per 100 ml. sat. sol. (S. & A.)	Gms. As_2O_3 per 100 ml. sat. sol. (S. & A.)	Gms. As_2O_3 per 100 ml. sat. sol. (G. & M.)	Gms. As_2O_3 per 100 ml. sat. sol. (S. & A.)	Solid Phase
...	...	...	< 0.006	Ca(OH)_2
0.0001 - 0.06	0.0002 - 0.07	*	0.011 - 0.08	Ca(OH)AsO_2
0.06 - 1.2	0.07 - 2.1	0.09 - 4.8	0.08 - 9.	$\text{Ca(AsO}_2)_2$
> 1.2	> 2.1	> 4.8	> 9.	As_2O_3

*The hydrate $2\text{CaO} \cdot \text{As}_2\text{O}_3 \cdot n\text{H}_2\text{O}$ is stable in contact with solutions containing 0.022 - 0.08% CaO .

CALCIUM ARSENATES $x\text{CaO} \cdot y\text{As}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

AsO

THE SYSTEM $\text{CaO} - \text{As}_2\text{O}_5 - \text{H}_2\text{O}$

The system has been investigated by many authors and in general there is good agreement as to the proportions of CaO and As_2O_5 in the solid phases, but the degree of hydration is still uncertain in many cases. The table below summarizes the results of the various authors, and shows the number of molecules of water assigned by each author to the compounds found by him. An x indicates that the compound was found,

Ca CALCIUM

THE SYSTEM $\text{CaO} - \text{As}_2\text{O}_5 - \text{H}_2\text{O}$ --Cont.

but the degree of hydration was not determined, and a (-) indicates that the compound was not found. Eisenberger, Lehrman, and Turner (1940) think that the continuous solid solutions exist in the basic region, rather than the 3:1, 10:3, and 4:1 compounds.

CaO:As ₂ O ₅	Tartar, Wood, and Hiner (1924) 25°	Smith (1920) 35°	Pearce and Avens (1937) 35°	Nelson and Haring (1937) 62°	Pearce and Norton (1936) 90°	Guerin (1941)			
						17°	40°	60°	90°
AsO	1:1	-	2	-	2	-	2	2	0,2
	2:1	-	3	x	1	x	3,5	3,5	3
	5:2	-	-	x	6	x	10	5	5
	3:1	-	-	x	2	x	10	4	2
	10:3	x	-	-	-	x	-	-	-
	4:1	-	-	-	x	-	5	1	1

Details of the various investigations

Equilibrium in the acid region at 35° (Smith, 1920)

An excess of CaO was added to aqueous solutions containing increasing amounts of arsenic acid. The mixtures were rotated continuously at 35° and the solutions analyzed at the end of 10 days and 17 days.

Density of sat. sol.	Gms. per liter of sat. sol.		Solid Phase	Density of sat. sol.	Gms. per liter of sat. sol.		Solid Phase
	CaO	As ₂ O ₅			CaO	As ₂ O ₅	
0.996	0.956	1.372	...	1.480	79.0	518.4	CaH ₄ (AsO ₄) ₂
1.025	7.20	27.79	CaHAsO ₄ ·H ₂ O	1.590	64.7	690.4	"
1.09	20.74	87.00	"	1.697	50.1	853.6	"
1.157	37.09	150.1	"	1.795	33.6	995.0	"
1.242	57.0	232.3	"	1.975	16.2	1230.0	"
1.261	58.2	252.1	"	2.167	2.93	1539.0	"
1.300	69.4	285.6	"	2.217	2.53	1599.0	" + 3As ₂ O ₅ ·5H ₂ O
1.413	92.5	405.4	CaH ₄ (AsO ₄) ₂				

Results at 25° (Robinson, 1918)

1 liter of water sat. with CaHAsO₄ contains 3.10 gms. of the compound.
1 " " " " " " Ca₃(AsO₄)₂ " 0.13 " " " "

The author also gives a few determinations which show that the presence of calcium hydroxide greatly reduces the solubility of the above two compounds.

EQUILIBRIUM IN THE BASIC REGION OF THE SYSTEM CALCIUM OXIDE,
ARSENIC PENTOXIDE AND WATER

This region has been intensively studied, especially in regard to the composition of the compounds formed.

Pearce and Norton, 1936, 1937, developed a technique for the rapid attainment of equilibrium. They found that when solid brine was shaken with solutions of arsenic acid, equilibrium was not reached in six weeks, even at 90°. When, however, brine was added in solution in such proportion that a precipitate would be obtained at 90°, but none at room temperature, it was found that no detectible change in the composition of the solution occurred after the first few hours. Such solutions were accordingly prepared on the basis of preliminary determinations to yield calculated amounts of precipitate varying from 50 to 500 milli-grams, and analyzed after two to ten days. During this time most of the solids became definitely crystalline. The authors report the identification at 90° of dicalcium arsenate, CaHAsO_4 , penta calcium arsenate, $\text{Ca}_5\text{H}_2(\text{AsO}_4)_4$, tri calcium arsenate, $\text{Ca}_3(\text{AsO}_4)_2$ and basic calcium arsenate $\text{Ca}_3(\text{AsO}_4)_2 \cdot 2\text{Ca}(\text{OH})_2$. The basic calcium arsenate was, however, not obtained at 35°. AsO

Clifford and Cameron, 1929, upon mixing and stirring large volumes of saturated solutions of calcium hydroxide and varying quantities of solutions of arsenic acid, obtained fluffy non crystalline precipitates in all cases. A period of 2 months at 25° was allowed for equilibrium. The ratios of As_2O_3 to CaO in the precipitates varied continuously from 1.08 to 1.60, thus indicating that they are members of a series of solid solutions.

Nelson and Haring, 1937, rotated constantly for nearly four months at 62°, mixtures of arsenic acid solutions and successively increasing amounts of calcium oxide in quantities to produce sufficient precipitates for analysis. Attainment of equilibrium was recognized by constancy in analytical results after successive intervals of time. No calcium arsenate more basic than $4\text{CaO} \cdot \text{As}_2\text{O}_5 \cdot x\text{H}_2\text{O}$ was obtained, hence precipitates more basic than this must be solid solutions. The other calcium arsenates which were identified were, CaHAsO_4 , $\text{Ca}_5\text{H}_2(\text{AsO}_4)_4 \cdot 5\text{H}_2\text{O}$ and $\text{Ca}_3(\text{AsO}_4)_2 \cdot 2\text{H}_2\text{O}$. In regard to the "Solubility" of calcium arsenates the authors state that "probably all the acid arsenates and the tri calcium salt react with water to form more basic solid phases, while the tetra calcium arsenate hydrolyzes in the opposite direction. It is evident, therefore, that the "solubility" of an arsenate of calcium depends on the conditions under which the determinations are made. The ordinary usage of the term "Solubility" of a compound implies an equilibrium condition between the solid and the solution, and also that the dissolved portion has the same chemical composition of the solid material after equilibrium is attained, depends upon the quantity of water used, that is, the extent to which the salt has been hydrolyzed."

Tarter, Wood and Hine, 1924 found that 100 gms. H_2O dissolve 0.0048 gm. basic arsenate of calcium, $3\text{Ca}_3(\text{AsO}_4)_2 \cdot \text{Ca}(\text{OH})_2$ at 25°.

ISOTHERMAL INVARIANT POINTS IN THE SYSTEM $\text{CaO} - \text{As}_2\text{O}_5 - \text{H}_2\text{O}$
(Guerin, 1939, 1941)

In order to obtain equilibrium, Guerin shook $\text{CaO} + \text{As}_2\text{O}_5$ and distilled water together for several hours in a thermostat constant to $\pm 2^\circ$. Occasionally one of the suspected compounds was used to prepare the original mixtures. Analyses were made of the wet residues or the

Ca CALCIUM

ISOTHERMAL INVARIANT POINTS IN THE SYSTEM $\text{CaO} - \text{As}_2\text{O}_5 - \text{H}_2\text{O}$ —Cont.

dried crystals after equilibrium was attained. The results agree well with those of Nelson and Haring (1937).

The solubility of crystalline tricalcium arsenate, containing 10 mols. H_2O of cryst., in water at 17° , is stated to be about 0.012 gm. of anhydrous salt per 100 gms. sat. solution.

	pH	Solution		Solid Phases ($\text{CaO}:\text{As}_2\text{O}_5:\text{H}_2\text{O}$)
		Wt. % CaO	Wt. % As_2O_5	
17°	2.4	6.5	27.5	1:1:2 + 2:1:3 (2:1:5?)
	6.8	0.09	0.32	2:1:3 + 5:2:10
	7.8	.05	.10	5:2:10 + 3:1:10
	9.6	.04	Trace	3:1:10 + 4:1:5
40°	2.4	6.6	28.5	1:1:2 + 2:1:3 (2:1:5?)
	6.4	0.09	0.23	2:1:3 + 5:2:5
	7.4	.03	.06	5:2:5 + 3:1:4
	9.0	.006	.008	3:1:4 + 4:1:1
60°	2.4	6.7	29.7	1:1:2 + 2:1:3
	6.2	0.07	0.2	2:1:3 + 5:2:5
	6.8	.03	.07	5:2:5 + 3:1:2
	7.8	.008	.017	3:1:2 + 4:1:1
90°	2.4	6.8	32.0	(1:1:0) 1:1:2 + 2:1:1 (2:1:3?)
	5.9	0.06	0.22	2:1:1 + 5:2:5
	6.2	.02	.07	5:2:5 + 3:1:2
	8.0	.009	.017	3:1:2 + 4:1:1

AsO CALCIUM POTASSIUM ARSENATE $2\text{CaO} \cdot \text{K}_2\text{O} \cdot \text{As}_2\text{O}_5 \cdot x\text{H}_2\text{O}$

CALCIUM AMMONIUM ARSENATE $2\text{CaO} \cdot (\text{NH}_4)_2\text{O} \cdot \text{As}_2\text{O}_5 \cdot x\text{H}_2\text{O}$

Results of Guerin, 1941b

$\text{Ca}(\text{H}_2\text{AsO}_4)_2$ forms a double salt in contact with KCl , NH_4Cl and NaCl solutions:

Orig. normality of KCl	Gms. per 100 gms. sat. sol.		pH	Orig. normality of NH_4Cl	Gms. per 100 gms. sat. sol.		pH
	CaO	As_2O_5			CaO	As_2O_5	
0.1	0.14	0.30	7.4	0.1	0.13	0.30	7.2
0.5	.18	.39	7.2	0.5	.24	.47	7.0
1	.19	.44	7.0	1	.33	.69	6.9
2	.20	.45	6.8	2	.39	.85	6.6
3	.19	.41	6.4	3	.41	.86	6.2
				4	.42	.88	6.0

CALCIUM BORATE CaB_2O_6

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THE SYSTEM $\text{CaO} - \text{B}_2\text{O}_3 - \text{H}_2\text{O}$ Results at 25°

(Nikolaev and Chelishcheva, 1940)

The authors found the same compounds in the system as did Sborgi (below) at 30° but some with different degrees of hydration. Mixtures of the oxides were allowed up to three months to attain equilibrium, rather than 5 days (Sborgi). The data show considerably smaller solubilities than the earlier work.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaO	B ₂ O ₃		CaO	B ₂ O ₃	
0.119	0.0	$\text{Ca}(\text{OH})_2$	0.053	0.955	2:3:13 + 1:3:4
.190	.102	" + 1:1:6	.044	1.34	1:3:4
.175	.104	1:1:6	.058	3.30	" + H_3BO_3
.090	.126	" + 2:3:13	0.0	3.17	H_3BO_3
.034	.380	2:3:13			

$$1:1:6 = \text{CaO} \cdot \text{B}_2\text{O}_3 \cdot 6\text{H}_2\text{O} \quad 2:3:13 = 2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 13\text{H}_2\text{O}$$

$$1:3:4 = \text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$$
Results at 30°

(Sborgi, 1913)

Many determinations in addition to these are given in the original paper.

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
B ₂ O ₃	CaO		B ₂ O ₃	CaO	
0.014	0.126	$\text{Ca}(\text{OH})_2$	0.869	0.067	2.3.9
0.032	0.140	"	1.116	0.076	"
0.098	0.194	"	1.339	0.093	" + 1.3.12
0.127	0.217	" + 1.1.6	2.058	0.093	1.3.12
0.134	0.220	1.1.6	2.509	0.099	"
0.138	0.118	"	2.730	0.111	"
0.162	0.106	"	3.732	0.325	"
0.166	0.107	" + 2.3.9	2.798	0.109	"
0.171	0.109	" "	3.313	0.143	"
0.290	0.052	2.3.9	3.841	0.152	"
0.610	0.054	"	4.250	0.155	" + H_3BO_3
0.767	0.059	"	4.179	0.137	H_3BO_3

$$1.1.6 = \text{CaO} \cdot \text{B}_2\text{O}_3 \cdot 6\text{H}_2\text{O}, \quad 2.3.9 = 2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 9\text{H}_2\text{O}, \quad 1.3.12 = \text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 12\text{H}_2\text{O}$$

INDIVIDUAL SOLUBILITIES OF VARIOUS CALCIUM BORATESSOLUBILITY OF CaB_2O_4 IN WATER IN THE PRESENCE
OF SMALL AMOUNTS OF BORIC ACID
(Mandelbaum, 1909)

Solid phase $\text{CaB}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$ (amorphous)			Solid phase $\text{CaB}_2\text{O}_4 \cdot 6\text{H}_2\text{O}$ (crystalline)		
Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
t°	B_2O_3	CaB_2O_4	t°	B_2O_3	CaB_2O_4
BO 30	0.0365	0.310	30	0.0205	0.254
50	0.036	0.307	50	0.032	0.353
70	0.048	0.392	70	0.068	0.457
90	0.0315	0.310	90	0.0675	0.359

SOLUBILITY OF PANDERMITE $[\text{Ca}(\text{H}_2\text{BO}_3)_2 \cdot \frac{1}{2}\text{H}_3\text{BO}_3]$
(Constable and Tugtepe, 1950)

[The 1952 results of these authors do not seem to involve pure solid phases]

In water at various temperatures			In boric acid solutions at 100°	
t°	Gms. $\text{Ca}(\text{H}_2\text{BO}_3)_2 \cdot \frac{1}{2}\text{H}_3\text{BO}_3$ per 100 cc sat. sol.	$\text{N}_{\text{H}_3\text{BO}_3}$	Gms. $\text{Ca}(\text{H}_2\text{BO}_3)_2 \cdot \frac{1}{2}\text{H}_3\text{BO}_3$ per 100 ml sat. sol.	
5	0.0576	0.01	0.0784	
16	.0612	.10	.0654	
32	.0922	.125	.0685	
38	.1005	.200	.0732	
50	.0990	.300	.0928	
75	.0976	.500	.1217	
100	.0926	.500	.1442	

Solubilities of other calcium borates:

$\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ("hexaborate").....6.03 gm/liter at 20° (Gode, 1949)

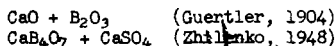
% B_2O_3 in a sat'd. soln. of
the salt at 25°

	in a sol'n. also	
	in water	sat'd. with gypsum
$2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 13\text{H}_2\text{O}$ (Inyoite).....	0.21	0.15
$2\text{CaO} \cdot \text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 16\text{H}_2\text{O}$ (Ulexite).....	.47	0.31
$\text{CaO} \cdot \text{MgO} \cdot 3\text{B}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ (Hydroboracite).....	.24	0.24

(Spiryagina, 1953)

The system $\text{CaO} - \text{Na}_2\text{O} - \text{B}_2\text{O}_3$ has been investigated at 25° by Kurnakova and Nikolaev, 1948. A diagram showing the region of stability of each saturating phase is given. The following phases were identified: $\text{Ca}(\text{OH})_2$, $\text{CaO} \cdot \text{B}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$, $2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 13\text{H}_2\text{O}$, $\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$, H_3BO_3 , $\text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$, $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$, $\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$, $\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$, NaOH . The only compound containing both sodium and calcium was $\text{Na}_2\text{O} \cdot 2\text{CaO} \cdot 5\text{B}_2\text{O}_3 \cdot 16\text{H}_2\text{O}$. The fields for $\text{Ca}(\text{OH})_2$, $\text{CaO} \cdot \text{B}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ and $2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 13\text{H}_2\text{O}$ occupy over 95% of the diagram.

Melting point data are given for:



CALCIUM tetramethoxy BOROHYDRIDE $\text{Ca}(\text{B}(\text{OCH}_3)_4)_2$

80

At 19° between 500-800 mg of the compound dissolve in tetrahydrofuran, benzene and cyclohexane. Slightly less dissolves in ethyl ether, ligroin and butyl ether. (Wiberg and Hartwimmer, 1955).

CALCIUM BROMIDE CaBr_2

Br

SOLUBILITY IN WATER (Kremers, 1858)

The data of Bliden (1953), Millikan (1917-18) at 25° and DeCarli (1932) at 11° are in reasonable agreement. Scott and Durham's (1930) value at 25° is too low. Freezing point depressions for the system are given by Rakowsky and Garrett (1954).

Gms. CaBr_2 per 100 Gms.

t°	Water	Solution	Solid Phase
-22	101	50.5	$\text{CaBr}_2 \cdot 6\text{H}_2\text{O}$ + Ice
0	125	55.5	$\text{CaBr}_2 \cdot 6\text{H}_2\text{O}$
10	132	57.0	"
20	143	58.8	"
25	153	60.5	"
34.2	185	65.1	$\text{CaBr}_2 \cdot 6\text{H}_2\text{O}$ + $\text{CaBr}_2 \cdot 4\text{H}_2\text{O}$
40	213	68.1	$\text{CaBr}_2 \cdot 4\text{H}_2\text{O}$
60	278	73.5	"
80	295	74.7	"
105	312	75.7	"

Density of saturated solution at 20° = 1.82.

SOLUBILITY OF CALCIUM BROMIDE IN AQUEOUS SOLUTIONS OF HYDROBROMIC ACID AT 25° (Scott and Durham, 1930)

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
HBr	CaBr_2	HBr	CaBr_2
0.0	58.53	7.23	50.09
3.48	54.24	10.84	48.67

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM BROMIDE, CALCIUM OXIDE AND WATER AT 25° (Millikan, 1917-1918)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CaO	CaBr ₂	Solid Phase	CaO	CaBr ₂	Solid Phase
0.0	60.07	CaBr ₂ ·6H ₂ O	0.080	32.92	D _{1.3.16}
0.209	60.09	" + D _{3.4.16}	0.080	32.50	"
0.192	59.48	D _{3.4.16}	0.089	28.21	"
0.199	58.90	"	0.089	25.15	"
0.235	56.94	"	0.092	22.39	"
0.271	55.29	"	0.103	21.80	"
Br 0.358	54.22	" + D _{1.3.16}	0.097	20.75	" + Ca(OH) ₂
0.247	53.39	D _{1.3.16}	0.115	19.18	Ca(OH) ₂
0.132	50.04	"	0.101	13.75	"
0.098	44.21	"	0.119	9.28	"
0.077	41.36	"	0.118	0.0	"

D_{3.4.16} = 3CaBr₂·4CaO·16H₂O. D_{1.3.16} = CaBr₂·3CaO·16H₂O.

THE SYSTEM CALCIUM BROMIDE - LITHIUM BROMIDE - WATER AT 25° (Bliden, 1953)

Gms. per 100 gms. sat. sol.		Gms. per 100 original complex		Solid Phase
CaBr ₂	LiBr	CaBr ₂	LiBr	
60.33	CaBr ₂ ·6H ₂ O
55.51	5.10	59.68	4.47	Solid Solution of CaBr ₂ ·6H ₂ O + LiBr·2H ₂ O
52.61	7.82	54.87	7.62	
48.24	12.54	51.16	12.31	
45.42	15.61	47.52	15.36	
42.46	19.12	45.01	18.82	
38.12	23.53	40.04	23.07	
33.46	28.48	36.12	28.52	
27.64	35.02	31.16	34.27	
26.41	37.63	28.87	37.11	LiBr·2H ₂ O
22.08	42.04	20.02	46.11	
17.56	46.62	13.50	52.48	
10.82	53.61	8.04	57.3	
...	64.71	

THE SYSTEM CALCIUM BROMIDE - INDIUM BROMIDE - WATER AT ROOM TEMPERATURE (Ensslin, Ziemeck, and deSchaepdryver, 1947)

Gms. per 100 ml. Sat. Sol.		Solid Phase	Gms. per 100 ml. Sat. Sol.		Solid Phase
InBr ₃	CaBr ₂		InBr ₃	CaBr ₂	
184.4	17.0	CaBr ₂ ·2InBr ₃ ·8H ₂ O	53.4	82.2	CaBr ₂ ·InBr ₃ ·8H ₂ O
180.1	20.0	"	47.3	83.4	3CaBr ₂ ·2InBr ₃ ·23H ₂ O
80.3	58.0	CaBr ₂ ·InBr ₃ ·8H ₂ O	39.8	85.3	"
76.9	76.5	"	29.0	90.8	2CaBr ₂ ·InBr ₃ ·14H ₂ O
61.8	78.0	"	26.4	93.8	"

THE SYSTEM CALCIUM BROMIDE - UREA - WATER AT 11°
(DeCarli, 1932)

Gms. per 100 gms. sat. sol.			
$\text{Co}(\text{NH}_2)_2$	CaBr_2	Solid Phase	
0.0	56.8	$\text{CaBr}_2 \cdot 6\text{H}_2\text{O}$	
3.50	56.18	"	
7.25	55.58	"	
8.20	55.05	" + $\text{CaBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2 \cdot 2\text{H}_2\text{O}$	
9.40	52.64	$\text{CaBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2 \cdot 2\text{H}_2\text{O}$	
13.74	47.70	"	
31.02	31.60	$\text{CaBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2 \cdot \text{H}_2\text{O}$	Br
41.77	26.11	"	
49.30	22.20	" + $\text{CO}(\text{NH}_2)_2$	
47.94	17.70	$\text{CO}(\text{NH}_2)_2$	
47.76	11.44	"	
40.84	0.0	"	

Freezing-point data are given for mixtures of calcium bromide and calcium chloride, calcium bromide and calcium fluoride by Ruff and Plato, 1903.

Freezing-point results for mixtures of calcium bromide and lithium bromide, calcium bromide and potassium bromide and calcium bromide and sodium bromide are given by Kellner, 1917.

SOLUBILITY OF CALCIUM BROMIDE IN ABSOLUTE ETHYL ALCOHOL
(Bonnell and Jones, 1926)

t°	Gms. CaBr_2 per 100 gms. $\text{C}_2\text{H}_5\text{OH}$	Solid Phase
0	46.70	$\text{CaBr}_2 \cdot 4\text{C}_2\text{H}_5\text{OH}$
10	48.01	"
15	50.51	"
17 (tr.pt.)		" + $\text{CaBr}_2 \cdot 3\text{C}_2\text{H}_5\text{OH}$
20	53.50	$\text{CaBr}_2 \cdot 3\text{C}_2\text{H}_5\text{OH}$
25	53.95	"
30	55.52	"
40	60.11	"
50	65.64	"
60	76.02	"
70	93.81	"
73.9 (tr.pt.)		" + $\text{CaBr}_2 \cdot \text{C}_2\text{H}_5\text{OH}$
75	102.20	$\text{CaBr}_2 \cdot \text{C}_2\text{H}_5\text{OH}$
80	103.10	"
85	106.10	"

Ca CALCIUM

SOLUBILITY OF CALCIUM BROMIDE IN METHYL, PROPYL, BUTYL, AMYL AND BENZYL ALCOHOLS

(Lloyd, Brown, Glynwyn, Bonnell and Jones, 1928)

In each case except in methyl alcohol the solid phase in contact with the saturated solution is the tri alcoholate of calcium bromide.

Gms. CaBr_2 per 100 gms.:

t°	Methyl alcohol	n Propyl alcohol	n Butyl alcohol
	CH_3OH	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	$\text{CH}_3(\text{CH}_2)_2\text{CH}_2\text{OH}$
0	50.4	6.6	18.3
10	52.0	13.0	25.3
20	56.2	22.5	33.9
30	62.9	35.0	43.7
40	71.9	49.2	54.3
50	83.2	63.4	64.8
60	97.8	76.8	75.2
70	105.6(65°)		

Gms. CaBr_2 per 100 gms.:

t°	n Amyl alcohol	iso Amyl alcohol	Benzyl alcohol
	$\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$	$(\text{CH}_3)_2\text{CH}(\text{CH}_2)_2\text{OH}$	$\text{C}_6\text{H}_5\text{CH}_2\text{OH}$
0	..	..	..
10	17.4	21.7	12.9
20	25.3	25.6	15.0
30	34.0	29.9	17.0
40	34.0	36.9	17.7
50	51.5	43.4	17.4
60	62.3	50.0	17.2
70	74.5	56.2	17.0

SOLUBILITY OF CALCIUM BROMIDE IN ABSOLUTE ACETONE

(Bell, Rowlands, Bamford, Thomas and Jones, 1930)

t°	Gms. CaBr_2 per 100 gms. CH_3COCH_3		Solid Phase	t°	Gms. CaBr_2 per 100 gms. CH_3COCH_3		Solid Phase
0	2.90		$\text{CaBr}_2 \cdot 2\text{C}_3\text{H}_6\text{O}$	30	2.72		$\text{CaBr}_2 \cdot 2\text{C}_3\text{H}_6\text{O}$
10	2.82		"	35	2.79		"
20	2.74*		"	40	2.92		"
25	2.72		"				

*Altata (1951) gives 2.746 at 20°.

SOLUBILITY OF CALCIUM BROMIDE IN LIQUID NH_3 AND SO_2

At 0°, 100 gms. sat. sol. in liquid ammonia contain 0.009 gm. CaBr_2 . (Linhard and Stephan, 1933, 1934).

At 25°, 100 gms. sat. sol. in liquid sulfur dioxide contain 0.02 gm. CaBr_2 . (Watt, Jenkins and Robertson, 1950).

CALCIUM PERBROMIDE CaBr_4 (?)

Br

Data for the formation of calcium perbromide in aqueous solutions at 25° are given by Herz and Bulla (1911). The experiments were made by adding bromine to aqueous solutions of CaBr_2 and agitating with carbon tetrachloride. From the bromine content of the CCl_4 layer, the amount of free bromine in the aqueous layer can be calculated on the basis of the distribution ratio of bromine between water and CCl_4 . This furnishes the necessary data for calculating the amount of calcium perbromide existing in the aqueous layer.

CALCIUM CARBIDE CaC_2

C

The melting points, densities, hardness and crystal structures of the system $\text{CaC}_2 + \text{CaO}$ are given by Aall (1939).

CALCIUM FORMATE $\text{Ca}(\text{HCOO})_2$

CH

SOLUBILITY IN WATER

(Lumsden, 1902; see also Krasnicki, 1887)

t°	Gms. $\text{Ca}(\text{HCOO})_2$ per 100 Gms.		t°	Gms. $\text{Ca}(\text{HCOO})_2$ per 100 Gms.	
	Water	Solution		Water	Solution
0	16.15	13.90	60	17.50	14.89
20	16.60	14.22	80	17.95	15.22
40	17.05	14.56	100	18.40	15.53

Results in good agreement with the above are given by Stanley, 1904; and by Ashton, Houston and Saylor, 1933.

SOLUBILITY OF CALCIUM FORMATE IN AQUEOUS SOLUTIONS OF FORMIC ACID AT 25°
(Dunn and Philip, 1934)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HCOOH	$\text{Ca}(\text{HCOO})_2$		HCOOH	$\text{Ca}(\text{HCOO})_2$	
0.0	14.43	$\text{Ca}(\text{HCOO})_2$	53.3	8.42	$\text{Ca}(\text{HCOO})_2$
18.48	12.11	"	61.6	7.60	"
27.41	11.16	"	69.9	6.86	"
36.31	10.20	"	85.4	5.43	"

Ca CALCIUM

RECIPROCAL SOLUBILITY OF CALCIUM FORMATE AND FORMIC ACID (Kendall and Adler, 1921)

t°	Mols. Ca(HCOO) ₂ per 100 mols. Ca(HCOO) ₂ + HCOOH	Solid Phase	t°	Mols. Ca(HCOO) ₂ per 100 mols. Ca(HCOO) ₂ + HCOOH	Solid Phase
8.4	0.0	HCOOH	35.0	1.54	Ca(HCOO) ₂
8.1	0.16	"	45.5	1.35	"
7.7	0.48	"	49.7	1.26	"
7.4	0.71	"	61.0	1.10	"
7.2	0.93	"	79.0	0.83	"
6.9	1.27	"	100.0	0.57	"
6.6	1.53	"	128.6	0.39	"
30.0	1.61	Ca(HCOO) ₂			

100 gms. methyl alcohol (CH₃OH) dissolve 0.27 gm. Ca(HCOO)₂ at 15° and 0.23 gm. at the b. pt. (66°). (Henstock, 1934).

CH CALCIUM METHIONATE CaCH₂(SO₃)₂

100 gms. H₂O dissolve 32.57 gms. CaCH₂(SO₃)₂ at 25°. (Backer and Terpstra, 1929).

100 gms. H₂O dissolve 33.30 gms. CaCH₂(SO₃)₂ at 15°. (Solid phase CaCH₂(SO₃)₂·2H₂O). (Valeri and Baumrucker, 1949).

100 gms. H₂O dissolve 44.66 gms. CaCH₂(SO₃)₂ at 25°. (Solid phase CaCH₂(SO₃)₂·3H₂O). (Valeri and Baumrucker, 1949).

CN CALCIUM ACETATE Ca(CH₃COO)₂

SOLUBILITY IN WATER (Lumsden, 1902; Krasnicki, 1887)

t°	Gms. Ca(CH ₃ COO) ₂ per 100 Gms.		Solid Phase	t°	Gms. Ca(CH ₃ COO) ₂ per 100 Gms.		Solid Phase
	Solu- tion	Water			Solu- tion	Water	
0	27.2	37.4	Ca(CH ₃ COO) ₂ ·2H ₂ O	60	24.6	32.7	Ca(CH ₃ COO) ₂ ·2H ₂ O
10	26.5	36.0	"	80	25.1	33.5	"
20	25.8	34.7	"	84	25.3	33.8	"
25	25.5*	34.2	"	85	24.7	32.9	Ca(CH ₃ COO) ₂ ·H ₂ O
30	25.3	33.8	"	90	23.7	31.1	"
40	24.9	33.2	"	100	22.9	29.7	"

*Dunn and Philip (1935) report 26.1

SOLUBILITY OF CALCIUM ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°
(Dunn and Philip, 1934)

Gms. per 100 gms. sat. sol.

CH_3COOH	$\text{Ca}(\text{CH}_3\text{COO})_2$	Solid Phase	
0.0	26.1	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	
2.1	25.4	"	
6.4	24.3	"	
7.5	24.7	"	
7.6	25.1	" + $\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{CH}_3\text{COOH} \cdot \text{H}_2\text{O}$	
10.8	21.7	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{CH}_3\text{COOH} \cdot \text{H}_2\text{O}$	
15.75	18.73	"	
26.3	14.7	"	CH
41.6	11.7	"	
58.6	9.2	"	
78.4	6.0	"	
86.2	4.12	"	

SOLUBILITY OF CALCIUM ACETATE IN AN AQUEOUS SATURATED SOLUTION
OF SUGAR AT 31.25°
(Kohler, 1897)

100 gms. solution contain 8.29 gms. $\text{Ca}(\text{CH}_3\text{COO})_2$ + 60.12 gms. sugar.

100 gms. water dissolve 26.3 gms. $\text{Ca}(\text{CH}_3\text{COO})_2$ + 190.3 gms. sugar.

The systems Calcium Acetate - Humic Acid - Water and Calcium Acetate - Methoxyhumic Acid - Water were studied by Fuchs, 1943.

RECIPROCAL SOLUBILITY OF CALCIUM ACETATE AND ANHYDROUS ACETIC ACID
DETERMINED BY THE FREEZING POINT METHOD
(Davidson and McAllister, 1930)

t°	Mols. $\text{Ca}(\text{CH}_3\text{COO})_2$ per 100 mols. $\text{Ca}(\text{CH}_3\text{COO})_2$ + CH_3COOH	Solid Phase
21.5	0.0594	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{CH}_3\text{COOH}$
23.6	0.0670	"
36.2	0.0933	"
37.2	0.0968	"
52.5	0.1576	"
60.9	0.2210	"
67.5	0.2823	"
75.1	0.3726	"
77.5	0.4005	"
82.8	0.4935	"
84.5	0.5398	"
85.2	0.5573	"
88.0	0.6287	"
89.0	0.6290	"
91.0	0.7082	"
97.8	0.9128	"
111.0	1.386	"

100 gms. Methyl Alcohol (CH_3OH) dissolve 0.75 gm. $\text{Ca}(\text{CH}_3\text{COO})_2$ at 15° and 1.01 gm. at the b. pt. (66°). (Henstock, 1934).

Ca CALCIUM

100 cc. anhydrous hydrazine dissolve 1 gm. calcium acetate at room temp. (Welsh and Broderick, 1915).

CALCIUM TRIFLUOROACETATE $(CF_3COO)_2Ca$

At 29.8°, 6.260 gms. $(CF_3COO)_2Ca$ dissolve in 100 gms. of CF_3COOH . The solid contains 4 molecules of solvent. (Hara and Cady, 1954).

CH CALCIUM (Tri) Methyl ACETATE $Ca[(CH_3)_3CCOO]_2$

CALCIUM (Di) Ethyl ACETATE $Ca[(C_2H_5)_2CHCOO]_2$

CALCIUM Methyl Ethyl ACETATE $Ca[CH_3(C_2H_5).CHCOO]_2$

SOLUBILITY OF EACH IN WATER
(Landau, 1893; Keppish, 1888; Sedlitzki, 1887)

t°	Ca. Tri Methyl Acetate		Ca. Di Ethyl Acetate		Ca. Methyl Ethyl Acetate	
	Gms. $Ca(C_3H_7O_2)_2$ per 100 Gms.		Gms. $Ca(C_4H_9O_2)_2$ per 100 Gms.		Gms. $Ca(C_3H_7O_2)_2$ per 100 Gms.	
	Water	Solution	Water	Solution	Water	Solution
0	7.30	6.81	30.3	23.22	28.78	22.35
10	6.84	6.40	27.8	21.75	31.71	24.07
20	6.54	6.14	25.6	20.38	33.76	25.23
30	6.40	6.01	23.7	19.16	34.92	25.89
40	6.44	6.05	22.1	18.10	35.20	26.04
50	6.64	6.22	20.8	17.22	34.60	25.71
60	6.86	6.42	19.9	16.60	33.11	24.89
70	7.11	6.64	19.2	16.11	30.74	23.41
80	7.38	6.87	..	...	27.49	21.56

CALCIUM Methyl Propyl ACETATE $\text{Ca}[(\text{C}_3\text{H}_7)_2\text{CHCOO}]_2$

CH

CALCIUM (Oi) Propyl ACETATE $\text{Ca}[(\text{C}_3\text{H}_7)_2\text{CHCOO}]_2$

SOLUBILITY OF EACH IN WATER
(Stiassny, 1891; Furth, 1888; Konig, 1894)

t°	Ca. Methyl Propyl Acetate		Ca. Di Propyl Acetate		Ca. Iso Butyl Acetate		CH
	Gms. Ca(C ₆ H ₁₁ O ₂) ₂ per 100 Gms.		Gms. Ca(C ₈ H ₁₅ O ₂) ₂ per 100 Gms.		Gms. Ca(C ₆ H ₁₁ O ₂) ₂ per 100 Gms.		
	Water	Solution	Water	Solution	Water	Solution	
0	16.58	14.22	9.57	8.73	7.48	6.96	
10	15.80	13.65	8.35	7.71	6.38	5.99	
20	15.14	13.15	7.19	6.71	5.66	5.36	
30	14.61	12.75	6.11	5.77	5.31	5.04	
40	14.21	12.45	5.09	4.84	5.31	5.04	
50	13.94	12.24	4.14	3.98	5.68	5.37	
60	13.79	12.13	3.25	3.15	6.41	6.02	
70	13.78	12.12	2.44	2.38	7.51	6.98	
80	13.89	12.20	1.65	1.62	8.97	8.23	
90	...	...	..	..	10.79	9.74	

CALCIUM PROPIONATE $\text{Ca}(\text{CH}_3\text{CH}_2\text{COO})_2 \cdot \text{H}_2\text{O}$

SOLUBILITY OF CALCIUM PROPIONATE IN WATER
(Lumsden, 1902; Krasnicki, 1887)

t°	Gms. $\text{Ca}(\text{C}_2\text{H}_5\text{COO})_2$ per 100 Gms..		t°	Gms. $\text{Ca}(\text{C}_2\text{H}_5\text{COO})_2$ per 100 Gms.	
	Solution	Water		Solution	Water
0	29.97	42.80	80	28.48	39.85
20	28.48	39.85	90	29.66	42.15
60	27.07	38.25	100	32.63	48.44

100 gms. Methyl Alcohol (CH_3OH) dissolve 1.25 gm. $\text{Ca}(\text{C}_2\text{H}_5\text{COO})_2$ at 15° and 3.31 gms. at the b. pt. (66°.1). Calcium propionate forms with methyl alcohol an alcoholate in the form of non hygroscopic prisms of the composition $\text{Ca}(\text{C}_2\text{H}_5\text{COO})_2 \cdot \text{CH}_3\text{OH}$. (Henetook, 1934).

CALCIUM LACTATE $(\text{CH}_3\text{CHONCOO})_2 \cdot 5\text{H}_2\text{O}$

100 gms. H_2O dissolve 3.1 gms. of the salt at 0°, 5.4 gms. at 15° and 7.9 gms. at 30°. (Hill and Cooking, 1912).

Ca CALCIUM

THE SOLUBILITY OF ANHYDROUS CALCIUM LACTATE IN METHYL ALCOHOL (Henstock, 1934)

Results estimated from the author's diagram.

t°	Gms. Ca(CH ₃ CHOHCOO) ₂ per 100 gms. CH ₃ OH	t°	Gms. Ca(CH ₃ CHOHCOO) ₂ per 100 gms. CH ₃ OH
15	11.0(13.3)	55	52.0
25	20.0	65	56.0
35	30.0	69.8(b. pt.)	73.8
45	41.0		

Evidence was determined that above 55° an alcoholate of the composition Ca(CH₃CHOHCOO)₂·5¹/₂CH₃OH was formed.

CH CALCIUM (Neutral) MALATE Ca(C₄H₄O₅)·3H₂O

CALCIUM (Acid) MALATE Ca(C₄H₅O₅)₂·6H₂O

CALCIUM MALONATE Ca(C₃H₂O₄)·4H₂O

SOLUBILITY OF EACH IN WATER

(Iwig and Hecht, 1886; Cantoni and Basadonna, 1906;
the malonate, Miczynski, 1886)

The results for calcium malonate given in parentheses are by Cantoni and Diotallevi (1905), but these authors fail to state the terms in which their data are reported. By comparison with other papers of the series, it is probable that in this case the figures refer to grams per 100 cc. saturated solution.

t°	<u>Ca. Neutral Malate*</u>			<u>Ca. Acid Malate</u>		<u>Ca. Malonate</u>
	Gms. Ca(C ₄ H ₄ O ₅) per 100			Gms. Ca(C ₄ H ₅ O ₅) ₂		Gms.
	Gms. H ₂ O	Gms. Sol.	cc. Sol. (C and B)	per 100 Gms.		Ca(C ₃ H ₂ O ₄) per 100 Gms. H ₂ O
				<u>Water</u>	<u>Solution</u>	
0	..	..	...	...	...	0.290 (0.374)
10	0.85	0.84	...	1.8	1.77	0.330 (0.419)
20	0.82	0.81	0.907	1.5	1.48	0.365 (0.460)
30	0.78	0.77	0.835	2	1.96	0.396 (0.495)
40	0.74	0.73	0.816	5.2	4.94	0.422 (0.524)
50	0.66	0.65	0.809	15	13.09	0.443 (0.544)
57	0.57	0.56	...	32.24	24.29	...
60	0.58	0.58	0.804	26	20.64	0.460
70	0.63	0.63	0.795	11	9.01	0.472
80	0.71	0.70	0.754	6.8	6.37	0.479
90	..	..	0.740			

*See also top of next page.

CALCIUM MALATE $\text{CaC}_4\text{H}_4\text{O}_5$ (See also p. 512)

CH

SOLUBILITY OF CALCIUM MALATE IN WATER AND IN ALCOHOL
(Parthell and Hubner, 1903)

100 gms. H_2O dissolve 0.9214 gm. $\text{CaC}_4\text{H}_4\text{O}_5 \cdot \text{H}_2\text{O}$ at 18° , and 0.8552 gm. at 25° .

100 gms. 95% alcohol dissolve 0.0049 gm. $\text{CaC}_4\text{H}_4\text{O}_5 \cdot \text{H}_2\text{O}$ at 18° , and 0.00586 gm. at 25° .

CALCIUM MALATES Active and Racemic Salts (See also p. 512)

SOLUBILITY OF EACH SEPARATELY IN WATER
(Duboux and Guttat, 1921)

Results for the active salt			Results for the racemic salt		
Gms. anhydrous salt per 100			Gms. anhydrous salt per 100		
t°	gms. sat. sol.	Solid Phase	t°	gms. sat. sol.	Solid Phase
0	0.670	$\text{C}_4\text{H}_4\text{O}_5\text{Ca} \cdot 2\text{H}_2\text{O}$	0.0	0.244	$\text{C}_8\text{H}_8\text{O}_{10}\text{Ca}_2 \cdot 3\text{H}_2\text{O}$
12.5	0.805	"	12.5	0.277	"
25.0	0.921	"	25.0	0.310	"
37.5	1.011	"	37.5	0.343	"

CALCIUM MALEATE $\text{CaC}_4\text{H}_2\text{O}_4$ and Acid Maleate $\text{Ca}(\text{C}_4\text{H}_3\text{O}_5)_2$

CH

SOLUBILITY OF EACH SEPARATELY IN WATER
(Weiss and Downs, 1923)

Gms. $\text{CaC}_4\text{H}_2\text{O}_4$ per 100 gms.			Gms. $\text{Ca}(\text{C}_4\text{H}_3\text{O}_5)_2$ per 100 gms.		
t°	H_2O	Solid Phase	t°	H_2O	Solid Phase
25	2.49	$\text{CaC}_4\text{H}_2\text{O}_4 \cdot \text{H}_2\text{O}$	25	21.13	$\text{Ca}(\text{C}_4\text{H}_3\text{O}_5)_2 \cdot 5\text{H}_2\text{O}$
40	2.88	"	40	41.89	"
			60	94.7°	"

CALCIUM (Normal) BUTYRATE $\text{Ca}[(\text{CH}_3(\text{CH}_2)_2\text{COO})_2 \cdot \text{H}_2\text{O}]$ CALCIUM (Iso) BUTYRATE $\text{Ca}[(\text{CH}_3)_2\text{CH} \cdot \text{COO}]_2 \cdot 5\text{H}_2\text{O}$

SOLUBILITY OF EACH IN WATER

(Lumsden, 1902; Chancel and Parmentier, 1887; Deezathy, 1893; Hecht, 1882. These latter authors give results for the normal salt which are somewhat below those of Lumsden for the lower temperatures. Sedlitzki, 1887 gives slightly different results for the iso salt.

Ca CALCIUM

SOLUBILITY OF EACH IN WATER--Cont.

Calcium Normal Butyrate

t°	Gms. $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 Gms.	
	Water	Solution
0	20.31	16.89
10	19.15	16.08
20	18.20	15.39
25	17.72	15.05
30	17.25	14.71
40	16.40	14.09
60	15.15	13.16
80	14.95	13.01
100	15.85	13.69

Calcium Iso Butyrate

t°	Gms. $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 Gms.		Solid Phase
	Water	Solution	
0	20.10	16.78	$\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2 \cdot 5\text{H}_2\text{O}$
10	22.40	18.30	"
20	23.80	19.23	"
30	23.80	19.23	"
40	25.28	20.65	"
60	28.40	22.12	"
62	28.70	22.30	"
65	28.25	22.03	$\text{Ca}(\text{C}_4\text{H}_7\text{O}_3)_2 \cdot \text{H}_2\text{O}$
80	27.00	21.26	"
100	26.10	20.69	"

CH CALCIUM FUMARATES $\text{CaC}_4\text{H}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ and (Acid Fumarate), $\text{Ca}(\text{C}_4\text{H}_3\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$

100 gms. H_2O sat. with $\text{CaC}_4\text{H}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ contain 1.56 gms. $\text{CaC}_4\text{H}_2\text{O}_4$ at 30°.

100 gms. H_2O sat. with $\text{Ca}(\text{C}_4\text{H}_3\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$ contain 5.19 gms. $\text{Ca}(\text{C}_4\text{H}_3\text{O}_4)_2$ at 30°. (Weiss and Downes, 1923).

CALCIUM 2-Methyl BUTYRATE d,l $\text{Ca}(\text{C}_4\text{H}_9\text{COO})_2 \cdot 5\text{H}_2\text{O}$

THE SOLUBILITY OF CALCIUM 2-METHYL BUTYRATE IN WATER (Houston, 1936)

t°	Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{COO})_2$ per 100 gms. H_2O	Solid Phase
0	23.05	$\text{Ca}(\text{C}_4\text{H}_9\text{COO})_2 \cdot 5\text{H}_2\text{O}$
10	23.60	"
20	24.55	"
30	27.15	"
36.5	29.90	" + $\text{Ca}(\text{C}_4\text{H}_9\text{COO})_2 \cdot \frac{1}{2}\text{H}_2\text{O}$
40	29.10	$\text{Ca}(\text{C}_4\text{H}_9\text{COO})_2 \cdot \frac{1}{2}\text{H}_2\text{O}$
50	26.60	"
60	24.45	"
70	22.80	"
80	21.40	"
90	20.35	"
100	19.80	"

CALCIUM TARTRATE $C_4H_4O_6Ca$

CH

SOLUBILITY IN WATER

The various data are in fair agreement
(Solid Phase $C_4H_4O_6Ca \cdot 4H_2O$)

t°	Gms. $C_4H_4O_6Ca$ per 1000 gms. H_2O		t°	Gms. $C_4H_4O_6Ca$ per 1000 gms. H_2O	
	Cantoni and Zachoder, 1905	Others		Cantoni and Zachoder, 1905	Others
0	0.264	0.192 ^d	35	...	....^d
10	0.290	...	37.5	...	0.498 ^d
12.5	...	0.268 ^d	40	0.633	...
18	...	0.275, 0.297 ^{cf}	50	0.795	....
20	0.344	0.364 ^{ae}	60	0.914	
25	0.380	0.360 ^{df}	70	1.034	
26-27	...	0.434 ^b	80	1.300	
30	0.457		85	1.584	

^aMagnanini, 1901. ^bHerz and Muhs, 1903 (gms. of "residue" dried at 70°).
^cPaul, 1915 (lower figure in CO_2 free water). ^dDuboux and Cuttat, 1921.
^eThe value of Francois and Lormand, 1923 (~.0175) is too low. ^fThe values of Partheil and Hubner, 1903 (.185, .295 at 18° and 25°) are too low. ^gRicherts (1930) value (0.476) is too high.

SOLUBILITY OF RACEMIC CALCIUM TARTRATE IN WATER.
(Duboux and Cuttat, 1921; Francois and Lormand, 1923)
(Solid Phase $C_6H_8O_{12}Ca_2 \cdot 8H_2O$)

t°	0	12.5	20(F.&L.)	25	37.5
Gms. $C_6H_8O_{12}Ca$ per 1000 gms. sat. sol.	0.023	0.032	0.0356	0.045	0.056

SOLUBILITY OF CALCIUM TARTRATE IN AQUEOUS SOLUTIONS OF TARTARIC ACID

Results at 18°
(Paul, 1915)

(The determinations were made by weighing the tartrate remaining undissolved and calculating the amount dissolved by difference. It was found that even a small amount of CO_2 in the water had a distinct influence on the solubility. One liter of pure CO_2 free water was found to dissolve 0.380 gm. $CaC_4H_4O_6 \cdot 4H_2O$ at 18° and one liter of ordinary distilled water, 0.410 gm. at the same temperature.)

Results for Aqueous Tartaric Acid Sols.		Results for Alcoholic Tartaric Acid Sols.	
Gms. per Liter		Gms. per Liter	
$C_4H_6O_6$	$CaC_4H_4O_6 \cdot 4H_2O$	C_2H_5OH	$CaC_4H_4O_6 \cdot 4H_2O$
1	0.910	50	0.263
2	1.162	"	1.107
4	1.511	"	1.85
6	1.776	80	0.205
8	1.972	"	0.867

Ca CALCIUM

SOLUBILITY OF CALCIUM TARTRATE IN AQUEOUS SOLUTIONS OF TARTARIC ACID-Cont.

Results at 18°--Cont.

(Paul, 1915)

Results for Aqueous Tartaric Acid Sols. Gms. per Liter			Results for Alcoholic Tartaric Acid Sols. Gms. per Liter		
$C_4H_6O_6$	$CaC_4H_4O_6 \cdot 4H_2O$		C_2H_5OH	$C_4H_6O_6$	$CaC_4H_4O_6 \cdot 4H_2O$
10	2.205		80	16	1.506
12	2.380		100	0	0.190
14	2.514		"	4	0.766
CH 16	2.643		"	16	1.297

Results at 20°

(Richert, 1930)

Gm. mols. per liter sat. sol.	
$H_2C_4H_4O_6$	$CaC_4H_4O_6$
0.0	0.00253
0.0067	0.00399
0.0268	0.00677
0.0469	0.00810
0.0670	0.00910

100 gms. aqueous 5% tartaric acid solution contain 0.1632 gm. $CaC_4H_4O_6$ at 20°. (Magnanini, 1901).

SOLUBILITY OF CALCIUM TARTRATE, $CaC_4H_4O_6 \cdot 4H_2O$, IN AQUEOUS ACETIC ACID SOLUTIONS AT 26°-27°

(Herz and Muhs, 1903; see also, Enell, 1899)

Normality of Acetic Acid	Gms. CH_3COOH per 100 cc Sol.	Residue from 50.052 cc Sol.	Normality of Acetic Acid	Gms. CH_3COOH per 100 cc Sol.	Residue from 50.052 cc Sol.
0	0	0.0217	3.80	22.80	0.2042
0.57	3.42	0.1082	5.70	34.20	0.1844
1.425	8.55	0.1635	10.09	60.54	0.1160
2.85	17.10	0.1970	16.505	93.03	0.0337

The residue was dried at 70° C.

Data for the effect of potassium chloride and of potassium acetate upon the solubility of calcium tartrate in aqueous 0.5 normal acetic acid solutions at 25°, and also for the effect of potassium mono-chloracetate upon the solubility of the salt in 0.5 normal chloracetic acid solutions at 25°, are given by Henderson and Taylor (1916).

SOLUBILITY OF CALCIUM TARTRATE IN AQUEOUS SALT SOLUTIONS

Results of Paul (1915) at 18°

Results for Aqueous Calcium Chloride Solution Gms. per Liter		Results for Aqueous Dipotassium Tartrate Sols. Gms. per Liter		CH
CaCl_2	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot \frac{1}{2}\text{H}_2\text{O}$	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	
0.503	0.202	0.392	0.166	
1.005	0.179	2.139	0.160	
3.518	0.166	2.352	0.157	
4.523	0.154	2.614	0.150	
5.025	0.154	4.705	0.223	
7.538	0.171	23.524	0.263	
10.05	0.177	47.048	0.305	
25.125	0.182			
50.25	0.224			

Results in Aqueous NH_4Cl , KCl , and NaCl
(Cantoni and Jolkowsky, 1907)

Note.--(The authors refer in all cases to their determination of the amount of decomposition of the tartrate by the aqueous chloride solutions. Constant agitation and temperature were maintained.)

Gms. Chloride per Liter Solvent	Gms. Ca Tartrate Dissolved at 16° per Liter of Aq.:			t°	Gms. Ca Tartrate per Liter of 7% Aqueous:		
	NH_4Cl	KCl	NaCl		NH_4Cl	KCl	NaCl
5	0.701	0.643	0.680	16	1.676	1.504	1.637
10	0.861	0.822	0.840	30	2.417	2.031	2.275
30	1.281	1.180	1.305	55	3.712	2.154	3.579
100	1.897	1.753	1.860	70	5.080	2.546	4.148
200	2.305	2.110	2.163	85	6.699	4.264	6.305

SOLUBILITY OF CALCIUM TARTRATE IN ETHANOL SOLUTIONS

100 gms. 10% alcohol solution contain 0.0160 gm. $\text{CaC}_4\text{H}_4\text{O}_6$ at 20°. (Magnanini, 1901).

100 gms. 95% alcohol solution contain 0.0187 gm. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ at 18° and 0.02352 gm. at 25°. (Partheil and Hubner, 1903).

100 cc. of 32% alcohol dissolve 0.0038 gms. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ at 20°. (Francois and Lormand, 1923).

Ca CALCIUM

CH CALCIUM SUCCINATE $\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$

CALCIUM (iso) SUCCINATE $\text{CaCH}_3\text{.CHC}_2\text{O}_4\text{.H}_2\text{O}$

SOLUBILITY OF EACH IN WATER (Miczynski, 1886)

Results for calcium succinate in water, varying considerably from these and indicating an increase of solubility with temperature, are given by Cantoni and Diotallevi (1905) but the terms used for expressing the results are not stated.

Calcium Succinate				Calcium Iso Succinate			
Gms. $\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$ per 100 Gms.	
t°	H ₂ O	t°	H ₂ O	t°	H ₂ O	t°	H ₂ O
0	1.127	40	1.177	0	0.522	50	0.440
10	1.220	50	1.029	10	0.524	60	0.396
15	1.28 (a)	60	0.894	20	0.517	70	0.342
18	1.277(b)	70	0.770	40	0.475	80	0.279
20	1.276	80	0.675				
25	1.287(b)	100	0.66 (a)				
	1.29 (c)						

a - (Targi and Sheoci, 1901)

b - (Partheil and Hubner, 1903)

c - (Walker, 1925).

SOLUBILITY OF CALCIUM SUCCINATE AT 25° IN AQUEOUS SOLUTIONS OF (Walker, 1925)

Magnesium Succinate		Sodium Succinate	
Gm. mols. per 1000 gms. H ₂ O		Gm. mols. per 1000 gms. H ₂ O	
$\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$	$\text{Mg}(\text{C}_2\text{H}_2\text{O}_2)_2$	$\text{Ca}(\text{C}_2\text{H}_2\text{O}_2)_2$	$\text{Na}_2(\text{C}_2\text{H}_2\text{O}_2)_2$
0.07769	0.04121	0.08252	0.0000
0.07474	0.06179	0.08013	0.00826
0.07374	0.08230	0.07103	0.0506
0.07173	0.1231	0.06495	0.1014
0.07087	0.1631	0.06138	0.1526

SOLUBILITY OF CALCIUM SUCCINATE IN ALCOHOL

100 cc. 95% alcohol dissolve 0.00136 gm. $\text{CaC}_4\text{H}_4\text{O}_4\text{.H}_2\text{O}$ at 18° and 0.00136 gm. at 25°. (Partheil and Hubner, 1903).

CALCIUM CACODYLATE $\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot 9\text{H}_2\text{O}$

CH

SOLUBILITY OF CALCIUM CACODYLATE IN WATER
(Tiollais, 1936)

t°	Gms. $\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2$ per 100 gms. sat. sol.	Solid Phase
0	32.42	$\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot 9\text{H}_2\text{O}$
4.5	33.35	"
9.0	34.53	"
19.0	37.27	"
24.0	39.11	"
27.0	40.43	"
32.5	42.62	"
34.7	43.70	"
42.0	47.17	"
45.0	49.73	"
48.5	54.89	" $\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot \text{H}_2\text{O}$
49.0	55.31	$\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2 \cdot \text{H}_2\text{O}$
52.5	55.35	"
57.0	56.14	"
61.0	56.83	"
63.5	57.10	"
64.0	57.29	" + $\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2$
67.0	56.74	$\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2$
75.0	55.40	"
88.0	55.20	"
98.0	55.05	"

SOLUBILITY OF CALCIUM CACODYLATE IN ALCOHOLS
(Tiollais, 1936)

Alcohol	t°	Gms. $\text{Ca}[(\text{CH}_3)_2\text{AsOO}]_2$ per 100 gms. sat. sol.
Methyl alcohol	16	39.95
Ethyl " (95%)	12	5.01
" " "	20	10.33
" " (100%)	12	16.06

CALCIUM VALERATE $\text{Ca}[\text{CH}_3(\text{CH}_2)_2\text{COO}]_2 \cdot \text{H}_2\text{O}$

CH

CALCIUM (iso) VALERATE $\text{Ca}[(\text{CH}_3)_2\text{CH} \cdot \text{CH}_2 \cdot \text{COO}]_2 \cdot 3\text{H}_2\text{O}$

SOLUBILITY OF EACH IN WATER

(Lumsden, 1902; Furth, 1888; Sedlitzky, 1887)

<u>Calcium Valerate</u>			<u>Calcium Iso Valerate</u>			Solid Phase
Gms. $\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2$ per 100 Gms.			Gms. $\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2$ per 100 Gms.			
t°	Water	Solution	t°	Water	Solution	
0	9.82	8.94	0	26.05	20.66	$\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$
10	9.25	8.47	10	22.70	18.50	"

(Cont.)

Ca CALCIUM

SOLUBILITY OF EACH IN WATER—Cont.

t°	Calcium Valerate Gms. $\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2$ per 100 Gms.		t°	Calcium Iso Valerate Gms. $\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2$ per 100 Gms.		Solid Phase
	Water	Solution		Water	Solution	
20	8.80	8.09	20	21.80	17.90	$\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$
30	8.40	7.75	30	21.68	17.82	"
40	8.05	7.45	40	22.00	18.18	"
50	7.85	7.28	45.5	22.35	18.42	"
57	7.75	7.19	50	19.95	16.63	$\text{Ca}(\text{C}_5\text{H}_9\text{O}_2)_2 \cdot \text{H}_2\text{O}$
60	7.78	7.22	60	18.38	15.52	"
70	7.80	7.24	70	17.40	14.82	"
80	7.95	7.36	80	16.88	14.44	"
90	8.20	7.58	90	16.65	14.28	"
100	8.78	8.07	100	16.55	14.20	"

CH CALCIUM GLUTAMATE $\text{Ca}(\text{CH}_2)_2\text{CH}(\text{NH}_2)(\text{COO})_2 \cdot 3\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM GLUTAMATE IN WATER (Takayama, 1930)

t°	0	19	21	61	100
Gms. $\text{CaC}_5\text{H}_7\text{NO}_4$ per 100 gms. sat. sol.	1.322	1.928	1.979	3.943	5.698

CALCIUM LEVULINATE $\text{Ca}[\text{CH}_3\text{CO}(\text{CH}_2)_2\text{COO}]_2 \cdot 2\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM LEVULINATE IN WATER (Cox, Dodds and Clasper, 1934)

t°	Gms. $\text{Ca}[\text{C}_5\text{H}_7\text{O}_3]_2$ per 100 gms. sat. sol.	Solid Phase
0	27.6	$\text{Ca}[\text{C}_5\text{H}_7\text{O}_3]_2 \cdot 2\text{H}_2\text{O}$
15.8	31.1	"
25.0	34.0	"
30.0	35.5	"
37.0	38.7	"
45.3	41.4	"
55.4	47.0	"

CH CALCIUM CITRATE $\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2$

SOLUBILITY OF THE TETRA- AND HEXAHYDRATES (Chatterjee and Dhar, 1924; Partheil and Hübner, 1903; Trimble, 1941)

Author	t°	$\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 4\text{H}_2\text{O}$ Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2$ per 100 gms. solvent		$\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 6\text{H}_2\text{O}$ Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2$ per 100 gms. solvent	
C.&D.	18	in H_2O	0.08496	...	
		in 95% ethanol	0.0065	...	
C.&D.	25	in H_2O	0.0959	...	
		in 95% ethanol	0.0089	...	
T.	25	in furfural	0.01	...	

SOLUBILITY OF CALCIUM CITRATE--Cont.

Author	t°		$\frac{\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 4\text{H}_2\text{O}}{\text{gms. Ca}(\text{C}_6\text{H}_5\text{O}_7)_2}$	$\frac{\text{Ca}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 6\text{H}_2\text{O}}{\text{gms. Ca}(\text{C}_6\text{H}_5\text{O}_7)_2}$
			per 100 cc sat. sol.	per 100 cc sat. sol.
P. & H.	30	in H ₂ O	0.22	0.201
P. & H.	95	in H ₂ O	0.183	0.227

EQUILIBRIUM IN THE SYSTEM CALCIUM OXIDE-CITRIC ACID-WATER AT 30°
(van Itallie, 1908)

The compositions of the solid phases were determined by the "Rest Method" of Schreinemakers (1903). The results are presented in the triangular diagram and it was necessary to select the fictitious compound $\text{C}_6\text{H}_4\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$ instead of $\text{C}_6\text{H}_8\text{O}_7$ in order to keep the citrate component within the limits of the diagram. This is in harmony with the choice of anhydrides as components in the inorganic oxy acid systems.

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
$\text{C}_6\text{H}_8\text{O}_7$ $1\frac{1}{2}\text{H}_2\text{O}$	CaO	Solid Phase	$\text{C}_6\text{H}_8\text{O}_7$ $1\frac{1}{2}\text{H}_2\text{O}$	CaO	Solid Phase
55.86	0	$\text{C}_6\text{H}_8\text{O}_7 \cdot \text{H}_2\text{O}$	20.3	0.35	$\text{C}_6\text{H}_8\text{O}_7 \text{Ca} \cdot 4\text{H}_2\text{O}$
54.8	0.24	"	16.3	0.33	"
55.4	0.35	" + $(\text{C}_6\text{H}_7\text{O}_7)_2 \text{Ca} \cdot 3\text{H}_2\text{O}$	12.5	0.39	"
53.7	0.40	$(\text{C}_6\text{H}_7\text{O}_7)_2 \text{Ca} \cdot 3\text{H}_2\text{O}$	8.3	0.28	"
48.3	0.52	"	5.2	0.25	"
42.6	0.60	"	4.1	0.20	Quadruple pt.
38.5	0.77	"	3.2	0.20	...
36.5	0.70	" + $\text{C}_6\text{H}_8\text{O}_7 \text{Ca} \cdot 4\text{H}_2\text{O}$	2.4-0	0.21-0.13	Hydrate of $(\text{C}_6\text{H}_8\text{O}_7)_2 \text{Ca}_2 (?)$
34.8	0.77	$\text{C}_6\text{H}_8\text{O}_7 \text{Ca} \cdot 4\text{H}_2\text{O}$	0.18	0.24	Quadruple pt.
27.5	0.45	"	0	0.113	$\text{Ca}(\text{OH})_2$

CALCIUM CAPROATE (Hexoate) $\text{Ca}[\text{CH}_3(\text{CH}_2)_4\text{COO}]_2 \cdot \text{H}_2\text{O}$

CH

CALCIUM 3 Methyl PENTANOATE $\text{Ca}[\text{CH}_3 \cdot \text{CH}_2 \cdot \text{CH}(\text{CH}_3)\text{CH}_2 \cdot \text{COO}]_2 \cdot 3\text{H}_2\text{O}$ CALCIUM CAPRYLATE $\text{Ca}[\text{CH}_3(\text{CH}_2)_4\text{COO}]_2 \cdot \text{H}_2\text{O}$

SOLUBILITY OF EACH IN WATER

(Lumsden; the Pentanoate, Kulish, 1893; see also Keppish, 1888, and Altschul, 1896, for results on the Caproate)

t°	Ca. Caproate		Ca. 3 Methyl Pentanoate		Ca. Caprylate
	Gms. Ca(C ₆ H ₁₁ O ₂) ₂		Gms. Ca(C ₆ H ₁₁ O ₂) ₂		Gms. Ca(C ₈ H ₁₅ O ₂) ₂
	per 100		per 100 Gms.		per 100
	Gms. H ₂ O		Water	Solution	Gms. H ₂ O
0	2.23		12.33	10.98	0.33
20	2.19		17.18	14.66	0.31

Ca CALCIUM

SOLUBILITY OF EACH IN WATER--Cont.

t°	<u>Ca. Caproate</u>	<u>Ca. 3 Methyl Pentanoate</u>			<u>Ca. Caprylate</u>
	Gms. $\text{Ca}(\text{C}_6\text{H}_{11}\text{O}_2)_2$	Gms. $\text{Ca}(\text{C}_6\text{H}_{11}\text{O}_2)_2$			Gms. $\text{Ca}(\text{C}_8\text{H}_{15}\text{O}_2)_2$
	per 100 Gms. H_2O	per 100 Gms.	Water	Solution	per 100 Gms. H_2O
40	2.15	18.99	15.97		0.28
50	2.10	18.73	15.78		0.26
60	2.15	17.71	15.04		0.24
80	2.30	13.37	11.80		0.32
100	2.57	9.94	9.04		0.50

CH CALCIUM GLUCONATE $\text{Ca}[\text{C}_6\text{H}_8(\text{OH})_5\text{COO}]_2$

SOLUBILITY OF CALCIUM GLUCONATE IN WATER
(De Carli, 1931; at 25°, May, Weisberg and Herrick, 1929)

t°	Gms. $\text{Ca}[\text{C}_6\text{H}_{11}\text{O}_7]_2$ per 100 gms. sat. sol.	t°	Gms. $\text{Ca}[\text{C}_6\text{H}_{11}\text{O}_7]_2$ per 100 gms. sat. sol.
20	3.596	69	13.19
25	3.85	90	26.90
40	5.022	96.4	36.40
60.2	10.80		

SOLUBILITY OF CALCIUM GLUCONATE IN AQUEOUS SOLUTIONS OF
MONOBASIC SODIUM PHOSPHATE AT 20° AND VICE VERSA
(De Carli, 1932)

Gms. per 100 gms. sat. sol.	$\text{Ca}[\text{C}_6\text{H}_{11}\text{O}_7]_2$	Solid Phase
NaH_2PO_4		
0.0	2.86	$\text{Ca}(\text{C}_6\text{H}_{11}\text{O}_7)_2$
2.70	3.00	"
4.01	3.11	$\text{Ca}(\text{C}_6\text{H}_{11}\text{O}_7)_2 \cdot \text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$
4.11	3.41	"
7.32	3.87	"
9.77	4.03	"
14.07	4.45	"
21.61	5.81	"
33.20	6.85	"
41.62	7.26	"
42.28	6.97	" + $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$
43.69	4.49	$\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$
44.54	2.55	"
46.00	0.00	"

CALCIUM Benzene SULFONATE $\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot \text{H}_2\text{O}$

The following 3 sets of data differ widely from each other.

SOLUBILITY OF CALCIUM BENZENE SULFONATE IN WATER
(Mameli, 1922)

t°	Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{SO}_2)_2$ per 100 cc. sat. sol.	t°	Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{SO}_2)_2$ per 100 cc. sat. sol.
0	1.766	20	1.844
10	2.001	30	1.211
15	1.968	40	0.410

According to Ephraim and Pfiater, (1925) 100 cc. sat. sol. in water contain 61.26 gms. $\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2$ at 20°.

SOLUBILITY OF CALCIUM BENZENE SULFONATE IN AQUEOUS SOLUTIONS
OF BENZENE SULFONIC ACID AT 25°
(Dunn and Philip, 1934)

Gms. per 100 gms. sat. sol.		
$\text{C}_6\text{H}_5\text{SO}_3\text{H}$	$\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2$	Solid Phase
0.0	28.07	$\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot \text{H}_2\text{O}$
15.01	15.78	"
27.30	8.18	"
36.12	4.09	"
37.33	3.48	"
64.00	0.07	"

CAIUM m and p Chloro BENZENE SULFONATES $\text{Ca}[\text{C}_6\text{H}_4\text{ClSO}_3]_2$

CH

SOLUBILITY OF EACH IN WATER
(Bollinger, 1928)

Results for m (1.5°)		Results for p (1.4°)	
$\text{Ca}[\text{C}_6\text{H}_4\text{ClSO}_3]_2$		$\text{Ca}[\text{C}_6\text{H}_4\text{ClSO}_3]_2$	
t°	Gms. per 100 cc sat. sol.	t°	Gms. per 100 cc sat. sol.
18	0.98	18	0.19
98	5.39	98	0.84

CAIUM BENZOATE $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$

SOLUBILITY OF CALCIUM BENZOATE IN WATER
(StanhrIDGE, 1918)

t°	Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 gms. H_2O	Solid Phase
-0.1	0.3098	Ice
-0.159	0.8964	"
-0.282	1.347	"
-0.308	1.421	"
-0.370	1.760	"
-0.382	2.263	"
-0.369	3.470	"
-0.37 (Eutec.)	2.22	" + $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot 3\text{H}_2\text{O}$
+0.2	2.232	$\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot 3\text{H}_2\text{O}$

Ca CALCIUM

SOLUBILITY OF CALCIUM BENZOATE IN WATER--Cont.

t°	Gms. $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 gms. H_2O	Solid Phase
9.8	2.453	$\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot 3\text{H}_2\text{O}$
15.	-- b	"
19.8	2.723	"
20.	-- c	"
26.	-- a	"
29.8	3.016	"
39.7	3.424	"
CH 49.7	4.048	"
59.8	4.708	"
69.9	5.675	"
79.9	6.865	"
90.2	8.555 *	"
84.7 (tr. pt.)	7.62	" + $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot \text{H}_2\text{O}$
82.9	7.518	$\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot \text{H}_2\text{O}$
85.0	7.588	"
87.0	7.708	"
89.1	7.850	"
91.1	8.005	"
93.1	8.135	"
95.2	8.379	"
97.2	8.464	"
100.0 (b. pt.)	8.695 ^b	"

*Metastable point.

^a100 cc. sat. solution in water contain 3.02 gms. $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ at 26°. (de Jong, 1912).^b100 gms. sat. solution in water contain 8.6 gms. $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ at 15° and 10.2 gms. at 100°. (Tarugi and Checchi, 1901).^c100 cc. sat. soln. contain 2.827 gms. $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ at 25°. (Ephraim and Pfister, 1925).SOLUBILITY OF SEVERAL SUBSTITUTED CALCIUM BENZOATES IN WATER AT 20°
(Ephraim and Pfister, 1925; Bailer, Jr. 1931)

Salt	Formula	(E. & P.)	(B.)
		Gms. anhydrous salt per 100 cc. sat. sol.	Gms. anhydrous salt per 100 cc. sat. sol.
Calcium benzoate	$\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot 2\text{H}_2\text{O}$	2.827	...
Calcium-4-chloro benzoate	$\text{Ca}(\text{C}_7\text{H}_4\text{O}_2\text{Cl})_2 \cdot 3\text{H}_2\text{O}$	0.737	0.914
" -4-nitro benzoate	$\text{Ca}(\text{C}_7\text{H}_4\text{O}_4\text{H})_2 \cdot 6\text{H}_2\text{O}$	2.548	...
" -4-oxy benzoate	$\text{Ca}(\text{C}_7\text{H}_5\text{O}_3)_2 \cdot 4\text{H}_2\text{O}$	8.366	...
" -4-methoxy benzoate	$\text{Ca}(\text{C}_8\text{H}_7\text{O}_3)_2 \cdot 3\text{H}_2\text{O}$	2.525	...
" -4-Bromo Benzoate	$\text{Ca}(\text{C}_6\text{H}_4\text{BrCOO})_2$	...	0.645
" -4-Iodo benzoate	$\text{Ca}(\text{C}_6\text{H}_4\text{ICOO})_2$	...	0.065

100 gms. Methyl Alcohol (CH_3OH) dissolve 0.25 gm. anhydrous $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ at 15° and 0.39 gm. at the b. pt. (66°); calcium benzoate forms with methyl alcohol an alcoholate of the composition $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2 \cdot \text{CH}_3\text{OH}$. (Henstock, 1934).

CALCIUM 2, 4-DINITRO PHENATE $\text{Ca}[\text{C}_6\text{H}_3(\text{NO}_2)_2\text{O}]_2$

CH

CALCIUM 2, 4-DINITRO CRESYLATE $\text{Ca}[\text{C}_6\text{H}_2(\text{CH}_3)(\text{NO}_2)_2\text{O}]_2$

Pastac and LeCrivain (1948).

At 15° between 1.0 and 2.0 wt. % Calcium 2,4-Dinitro Cresylate dissolve in water.

At 4° between 0.5 and 1.0 wt. % Calcium 2,4-Dinitro Phenate dissolve in water.

At 15° between 1.0 and 2.0 wt. % Calcium 2,4-Dinitro Phenate dissolve in water.

CALCIUM SALICYLATE $\text{Ca}(\text{C}_6\text{H}_4.\text{OHCOO})_2 \cdot 3\text{H}_2\text{O}$

100 grams of the saturated aqueous solution contain 2.29 grams of the anhydrous salt at 15° and 35.75 grams at 100°. (Tarugi and Checchi, 1901).

CALCIUM ACETYSALICYLATE $\text{Ca}(\text{C}_6\text{H}_4(\text{OCOCH}_3)\text{COO})_2$

CH

33.5% dissolved in ether after standing for 16 hours at room temperature.

35.2% dissolved in Absolute Alcohol after standing for 3 hours at room temperature. (Ebach, 1943).

CALCIUM TETRACHLORO PHTHALATE $\text{CaC}_6\text{Cl}_4(\text{COO})_2$

100 gms. of a saturated solution of the salt in water contains 0.07 gms. at 24°. (Lawlor, 1947).

CALCIUM HEPTANOATE (Oenanthane) $\text{Ca}[\text{CH}_2(\text{CH}_2)_5\text{COO}]_2 \cdot \text{H}_2\text{O}$

SOLUBILITY IN WATER

(Lumsden, 1902; see also Landau, 1893; Altschul, 1896)

t°	0°	20°	40°	60°	80°	100°
Gm. $\text{Ca}(\text{C}_7\text{H}_{13}\text{O}_2)_2$ per 100						
gms. solution	0.94	0.85	0.81	0.81	0.97	1.24

CALCIUM Racemic β MethylADIPATE $\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2(\text{COO})_2\text{Ca}$ 100 cc. of saturated solution of the neutral calcium salt of racemic β methyl adipic acid in water contain 5.3 gms. of the compound at 15°. (Meurisse).

Ca CALCIUM

CH CALCIUM MECONATE $C_7H_2O_7 \cdot Ca$

1000 cc. of sat. sol. in 0.1 n aqueous ammonia contain 0.0973 gm. $C_7H_2O_7Ca$ at 18°. (Heiduschka and Faul, 1917).

CALCIUM THEOBROMINE $Ca(C_7H_6N_4O_2)_2$

SOLUBILITY OF CALCIUM THEOBROMINE IN AQUEOUS SOLUTION OF CALCIUM NITRITE AT 16° (Kaufmann, 1935)

Gms. per 100 gms. H ₂ O			Gms. per 100 gms. H ₂ O		
$Ca(NO_2)_2 \cdot H_2O$	$Ca(Th)_2$	Solid Phase	$Ca(NO_2)_2 \cdot H_2O$	$Ca(Th)_2$	Solid Phase
0	0.45	$Ca(Th)_2$	50	3.2	$Ca(Th)_2 + Ca(Th)_2 \cdot Ca(NO_2)_2 \cdot 3H_2O$
5	0.46	"	55	1.52	$Ca(Th)_2 \cdot Ca(NO_2)_2 \cdot 3H_2O$
10	0.58	"	60	1.01	"
20	0.81	"	70	0.63	"
30	1.22	"	110	0.18	"
40	1.90	"			

CH CALCIUM MANDELATES, Racemic and Active, $Ca(C_8H_7O_3)_2$

SOLUBILITY OF EACH SEPARATELY IN AQUEOUS SOLUTIONS OF (r) AND (-) MANDELIC ACID AT 25° (Ross and Morrison, 1933; Ross, Morrison and Johnstone, 1937)

Results for the Racemic (r) Compounds Results for the Active (-) Compounds

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
$C_8H_8O_3$	$Ca(C_8H_7O_3)_2$	Solid Phase	$C_8H_8O_3$	$Ca(C_8H_7O_3)_2$	Solid Phase
0.0	1.8	$Ca(C_8H_7O_3)_2$	0.0	2.3	$Ca(C_8H_7O_3)_2$
0.4	1.7	" + 1.1	2.9	2.1	"
1.2	0.7	1.1	5.7	2.6	" + 1.1
4.2	0.2	"	7.0	2.1	1.1
6.5	0.1	"	8.2	2.1	"
10.5	0.1	"	9.2	1.8	" + 1.2
12.2	0.1	"	9.4	1.9	1.2
14.1	0.1	"	9.6	1.5	"
16.9	0.0	$C_8H_7O_3$	11.2	1.4	$C_8H_7O_3$
			10.2	1.0	"
			10.1	0.0	"

1.1 = $Ca(C_8H_7O_3)_2 \cdot (C_8H_8O_3)_2$
1.2 = $Ca(C_8H_7O_3)_2 \cdot 2(C_8H_8O_3)_2$

CALCIUM XYLENE SULFONATES o, m and p $\text{Ca}(\text{C}_6\text{H}_4\text{SO}_3)_2$

CH

SOLUBILITY OF EACH SEPARATELY IN WATER AT 25°
(Nakatsuhi, 1930)

Compound	Formula	Gms. Compd. per 100 gms. H_2O
Calcium o xylene sulfonate	$\text{Ca}(\text{C}_6\text{H}_3(\text{CH}_3)_2\text{SO}_3)_2$	21.91
" m " "	"	32.67
" p " "	"	11.81

CALCIUM CINNAMATE $\text{Ca}(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2 \cdot 3\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM CINNAMATE AND ITS ISOMERS IN SEVERAL SOLVENTS

Name of Salt	Formula	Solvent	t°	Gms. Anhydrous Salt per 100 Gms. Solvent
Calcium Cinnamate	$\text{Ca}(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2 \cdot 3\text{H}_2\text{O}$	Water	2	0.19(1)
" "	"	"	15	0.21(2)
" "	"	"	20	0.341(6)
" "	"	"	26	0.24(1)
" "	"	"	100	1.15(2)
" Isocinnamate	$\text{Ca}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	"	20	23.8 (3)
" "	"	Acetone	20	19.6 (3)
" Allocinnamate	$\text{Ca}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$	"	20	2 (3)
" "	$\text{Ca}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	Water	20	10.2 (4)
" "	"	Acetone	18	2.7 (5)
" Hydrocinnamate	$\text{Ca}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 7\text{H}_2\text{O}$	"	24	0.19(5)
" "	"	"	19	0.21(5)
" "	"	"	25	3.3 (3)
" "	"	Water	27	4.25(3)

(1) = De Jong, 1909; (2) = Tarugi and Checchi, 1901; (3) = Michael, 1901; (4) = Liebermann, 1903; (5) = Michael and Garner, 1903; (6) = Ephraim and Pfister, 1925.

CALCIUM PELARGONATE (Nonate) $\text{Ca}[\text{CH}_3(\text{CH}_2)_7\text{COO}]_2 \cdot \text{H}_2\text{O}$

CH

SOLUBILITY OF CALCIUM PELARGONATE IN WATER
(Lumsden, 1902; Krasnicki, 1887)

t°	Gms. $\text{Ca}[\text{CH}_3(\text{CH}_2)_7\text{COO}]_2$ per 100 gms. H_2O	t°	Gms. $\text{Ca}[\text{CH}_3(\text{CH}_2)_7\text{COO}]_2$ per 100 gms. H_2O
0	0.16	80	0.15
20	0.14	90	0.18
40	0.13	100	0.26
60	0.12		

CALCIUM 8-HYDROXYQUINOLATE (OXINE) $\text{Ca}(\text{C}_9\text{H}_6\text{NO})_2$

The solubility product constant at zero ionic strength is $10^{-11.12}$.
(Nasanen, 1951).

Ca CALCIUM

CALCIUM 8-HYDROXYQUINOLINE-5 SULFONIC ACID

CALCIUM 7-iodo-8-HYDROXYQUINOLINE-5 SULFONIC ACID (both Acid and Normal Salts)

The solubility products were determined by Nasanen and Uusitalo, 1954 and Ekman and Nasanen (1953) respectively.

CALCIUM 5 and 7 ISOQUINOLINE CARBOXYLATE (C_9H_6NCOO)₂Ca

Data for the solubility in water at approximately 25° and 100° are given by Tyson, 1939.

CH CALCIUM d CAMPHORATE $C_{10}H_{14}O_4Ca \cdot 7H_2O$

SOLUBILITY OF CALCIUM CAMPHORATE IN AQUEOUS SOLUTIONS OF CAMPHORIC ACID AT 15° AND VICE VERSA (Jungfleisch and Landrieu, 1914)

Gms. per 100 Gms. Sat. Sol.		Solid Phase
$C_8H_{14}(COOH)_2$	$C_{10}H_{14}O_4Ca$	
1.35	1.23	$C_8H_{14}(COOH)_2$
1.57	1.97	"
1.71	2.55	"
2.18	4.34	"
2.33	4.73	"
2.90	7.75	"
3.00	8.66	" + $C_{10}H_{14}O_4Ca \cdot 7H_2O$
3.07	8.57	$C_{10}H_{14}O_4Ca \cdot 7H_2O$
1.50	7.94	"
0	7.37	"

Calcium camphorate tetrahydrate exists at higher temperatures. Its solubility at 100° was found to be 8.68 gms. $C_{10}H_{14}O_4Ca$ per 100 gms. sat. solution. By careful work, the results at 15° for $C_{10}H_{14}O_4Ca \cdot 4H_2O$ was found to be 12.21 gms. $C_{10}H_{14}O_4Ca$ per 100 gms. sat. solution.

CH CALCIUM ALKYL SULFONATES

SOLUBILITY OF EACH SEPARATELY IN WATER (Reed and Tartar, 1936)

Compound	Formula	t°	Gms. anhydrous cmpd. per 100 gms. H ₂ O
Calcium n Decyl Sulfonate	$Ca[CH_3(CH_2)_8CH_2SO_3]_2$	25	0.155 (1)
" " "	"	60	0.260 (1)
" Lauryl "	$Ca[CH_3(CH_2)_{10}CH_2SO_3]_2$	25	0.011 (1)
" " "	"	60	0.033 (1)
" Myristyl "	$Ca[CH_3(CH_2)_{12}CH_2SO_3]_2$	25	0.0014 (1)
" " "	"	60	0.0050 (1)

(Cont.)

SOLUBILITY OF EACH SEPARATELY IN WATER—Cont.

Compound	Formula	t°	Gms. anhydrous cmpd. per 100 gms. H ₂ O
Calcium Cetyl Sulfonate	$\text{Ca}[\text{CH}_3(\text{CH}_2)_{14}\text{CH}_2\text{SO}_3]_2$	25	0.0005 (1)
" " "	" "	60	0.0013 (1)
" n Octyldecyl Sul.	$\text{Ca}[\text{CH}_3(\text{CH}_2)_{16}\text{CH}_2\text{SO}_3]_2$	25	0.0006 (1)
" " "	" "	60	0.0007 (1)

CALCIUM CYMENE SULFONATE $\text{Ca}[\text{CH}_3\text{C}_6\text{H}_4(\text{CH}_2)_3\text{SO}_3]_2$

CH

SOLUBILITY OF CALCIUM CYMENE SULFONATE IN WATER
(Hauslick, 1935)

t°	Gm. mols. $\text{Ca}[\text{CH}_3\text{C}_6\text{H}_4(\text{CH}_2)_3\text{SO}_3]_2$ per 100 gms. H ₂ O	t°	Gm. mols. $\text{Ca}[\text{CH}_3\text{C}_6\text{H}_4(\text{CH}_2)_3\text{SO}_3]_2$ per 100 gms. H ₂ O
1.0	0.003	79	0.062
30.0	0.011	93	0.111
37.0	0.016	99	0.192
64.0	0.022		

CALCIUM SODIUM ETHYLENE dinitrilo tetraACETATE $\text{CaNa}_2\text{C}_{10}\text{H}_{12}\text{O}_8\text{N}_2 \cdot 4\text{H}_2\text{O}$

At 30° a saturated solution is 0.1M. (Astakhov and Kiseleva, 1950).

CALCIUM DODECYL SULFATE $\text{Ca}(\text{C}_{12}\text{H}_{25}\text{SO}_4)_2$

CH

SOLUBILITY IN SOLUTIONS OF SODIUM DODECYLSULFATE AT 50°
(Tarter and Cadle, 1939)

Gms. per 100 gms. H ₂ O			
NaD	CaD	NaD	CaD
0.0	0.261	1.250	4.30
.200	1.25	2.500	7.27
.600	2.60		

CALCIUM DODECYLSULFONATE $\text{Ca}(\text{C}_{12}\text{H}_{25}\text{SO}_3)_2$ SOLUBILITY IN SOLUTIONS OF SODIUM DODECYLSULFONATE AT 50°
(Tarter and Cadle, 1939)

Gms. per 100 gms. H ₂ O			
NaD	CaD	NaD	CaD
0.0	0.0220	1.5000	0.135
.0125	.0166	2.5000	.171
.0300	.0067	5.000	.260
.1000	.0028	10.000	.440
.2000	.0043	15.000	.820
.6000	.0260		

Ca CALCIUM

CH CALCIUM NAPHTHALENE SULFONATE NAPHTHYLAMINE ANTHRACENE PHENANTHRENE ANTHRAQUINONE

SOLUBILITY OF EACH SEPARATELY IN WATER

Compound	Formula	t°	Gms. anhy. compd. per 100 gms. sat. sol.	
Calcium Naphthalene-2-Sulfonate	$\text{Ca}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot \text{H}_2\text{O}$	16.5	1.98	(1)
" " 1,4 Chlor Sulfonate	$\text{Ca}(\text{C}_{10}\text{H}_6\text{ClSO}_3)_2 \cdot 7\text{H}_2\text{O}$	18	0.19	(2)
" " " " "	"	98	0.84	(2)
" " 1,5 " "	$\text{Ca}(\text{C}_{10}\text{H}_6\text{ClSO}_3)_2 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	18	0.98	(2)
" " " " "	"	20	0.37	(1)
" " " " "	"	98	5.11	(2)
" Naphthylamine 2,5,7 Di Sulfonate	$\text{Ca}(\text{C}_{10}\text{H}_5\text{NH}_2\text{SO}_3)_2$	15	40.2	(3)
" " 2,5,8 " "	"	15	29.1	(3)
" " 1,2,4,7 Tri " "	$\text{CaC}_{10}\text{H}_4\text{NH}_2(\text{SO}_3)_2\text{H}$	20	14.4	(4)
" " " " "	"	80	24.2	(4)
" Anthracene -1- Sulfonate	$\text{Ca}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot 3\text{H}_2\text{O}$	20	0.027	(1)
" " " " "	"	20	0.0266	(8)
" " " " "	"	100	0.3286	(8)
" " " " "	"	20	0.016	(1)
" " " " "	"	20	0.0162	(8)
" " " " "	"	100	0.1034	(8)
" " 1,5 " "	$\text{C}_{14}\text{H}_8\text{S}_2\text{O}_6\text{Ca} \cdot 3\text{H}_2\text{O}$	20	0.2666	(8)
" " " " "	"	100	0.5248	(8)
" " 1,8 " "	$\text{C}_{14}\text{H}_8\text{S}_2\text{O}_6\text{Ca} \cdot 5\text{H}_2\text{O}$	20	0.1840	(8)
" " " " "	"	100	0.3544	(8)
" " 2,6 " "	$\text{C}_{14}\text{H}_8\text{S}_2\text{O}_6\text{Ca} \cdot 5\text{H}_2\text{O}$	20	0.2424	(8)
" " " " "	"	100	0.4425	(8)
" " 2,7 " "	$\text{C}_{14}\text{H}_8\text{S}_2\text{O}_6\text{Ca} \cdot 3\text{H}_2\text{O}$	20	0.1072	(8)
" " " " "	"	100	0.2107	(8)
" Phenanthrene -2- " "	$\text{Ca}(\text{C}_{14}\text{H}_9\text{SO}_3)_2$	20	0.024	(5)
" " -3- " "	$\text{Ca}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot 2\text{H}_2\text{O}$	20	0.083	(5)
" " -10- " "	"	20	0.300	(5)
" " 10Chlor -3- Sulfonate	$\text{Ca}(\text{C}_{14}\text{H}_8\text{ClSO}_3)_2 \cdot \text{H}_2\text{O}$	20	0.015	(6)
" Anthraquinone-1- " "	$\text{Ca}(\text{C}_{14}\text{H}_7\text{O}_2\text{SO}_3)_2 \cdot 3\text{H}_2\text{O}$	18	0.41	(7)
" " " " "	"	100	1.79	(7)
" " 1,5 Di " "	$\text{CaC}_{14}\text{H}_8\text{O}_2(\text{SO}_3)_2 \cdot 3\text{H}_2\text{O}$	18-100	0.91	(7)
" " 1,6 " " "	$\text{CaC}_{14}\text{H}_6\text{O}_2(\text{SO}_3)_2 \cdot 5\text{H}_2\text{O}$	18	1.51	(7)
" " " " "	"	100	14.2	(7)
" " 1,7 " " "	$\text{CaC}_{14}\text{H}_6\text{O}_2(\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	18-100	14.2	(7)
" " 1,8 " " "	$\text{CaC}_{14}\text{H}_6\text{O}_2(\text{SO}_3)_2 \cdot 5\frac{1}{2}\text{H}_2\text{O}$	18	0.07	(7)
" " " " "	"	100	1.12	(7)
" " 1,5 Chloro Sulfonate	$\text{Ca}(\text{C}_{14}\text{H}_6\text{O}_2\text{ClSO}_3)_2 \cdot 2\text{H}_2\text{O}$	18	0.13	(7)
" " " " "	"	100	0.40	(7)
" " 1,6 " " "	"	18	0.15	(7)
" " 1,7 " " "	"	18	1.31	(7)
" " 1,8 " " "	$\text{Ca}(\text{C}_{14}\text{H}_6\text{O}_2\text{ClSO}_3)_2 \cdot 4\text{H}_2\text{O}$	18	0.39	(7)
" " " " "	"	100	1.96	(7)

- (1) Ephraim and Pfister, 1925(a); (2) Ferrero and Bolliger, 1928;
(3) Braunschweig, 1922-26; (4) Frisch, 1934; (5) Sandquist, 1912;
(6) Sandquist, 1917; (7) Fierz-David, Krebsner and Anderau, 1927;
(8) Federov and Lodygin, 1942.

CH CALCIUM HELIANTHATE $\text{Ca}(\text{C}_{14}\text{H}_{14}\text{N}_3\text{SO}_3)_2 \cdot 4\text{H}_2\text{O}$

1000 cc. H_2O dissolve 0.177 gms. calcium helianthate at 20-25°.
(Stark and Dehn, 1918).

CALCIUM

CALCIUM Ca

CALCIUM OLEATE $(C_{18}H_{33}O_2)_2Ca$

CH

CALCIUM PALMITATE $[CH_3(CH_2)_{14}COO]_2Ca$

CALCIUM STEARATE $[CH_3(CH_2)_{16}COO]_2Ca$

SOLUBILITY OF EACH SEPARATELY IN WATER AND IN AQUEOUS-SODIUM CHLORIDE SOLUTIONS (Zink and Liere, 1915)

About 0.25 gm. of each compound was rubbed with water and allowed to stand at room temperature for 36 hours. The solution was filtered, and the Ca in 750 cc. determined.

Milligrams per liter of sat. sol.

Solvent	$(C_{18}H_{33}O_2)_2Ca$	$[CH_3(CH_2)_{11}COO]_2Ca$	$[CH_3(CH_2)_{16}COO]_2Ca$
Water	65.88-91.67	27.50-28.77	38.95-41.87
Aq. 0.05% NaCl	77.38	39.28	46.20
0.10 "	102.5	56.27	69.24

SOLUBILITY OF CALCIUM OLEATE IN SEVERAL SOLVENTS

Solvent	t°	Gms. $Ca(C_{18}H_{33}O_2)_2$ per 100 gms. solvent	Authority
Water	(?)	0.01	(Farion, 1916)
Methyl alcohol	15	0.30	(Henstock, 1934)
" " (at b. pt.)	66	0.57	(")
Acetone	15	2.26	(")
Benzene	15	3.44	(")
Glycerol (d = 1.114)	(?)	1.18	(Asselin, 1873)

Experiments upon the solubility of Calcium Stearate in aqueous solutions of bile showed that at about 23° concentrations of bile up to 16 volume percent do not appreciably increase the amount of calcium stearate dissolved in water alone. The solubility product of calcium stearate in water, calculated from the calcium determination is $(Ca) \times (Stearate\ ion) = 3.61 \times 10^{-15}$. (Langley, Rosenbaum and Rosenbaum, 1932).

A phase diagram for the system calcium stearate - cetane is given by Vold and Vold (1950). The system calcium stearate - cetane - water was studied by x-ray diffraction by Vold and Smith (1951).

CALCIUM THIOCYANATE $Ca(SCN)_2$

CNS

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE - POTASSIUM THIOCYANATE - WATER AT 25° (McKerrow, Occlessshaw, and Drabble, 1946)

Calcium Thiocyanate Tetrahydrate exists in two forms: An α form stable above 23.8° and a β form stable below this temperature.

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE -
POTASSIUM THIOCYANATE - WATER AT 25°--Cont.

	Gms. KSCN per 100 gms. Sat. Sol.	Gms. Ca(SCN) ₂ per 100 gms. Sat. Sol.	Solid	Gms. KSCN per 100 gms. Sat. Sol.	Gms. Ca(SCN) ₂ per 100 gms. Sat. Sol.	Solid
	70.76	0.0	A	24.00	46.65	C
	66.16	4.01	A	18.62	51.82	C
	59.32	10.51	A	17.77	53.18	C + α-D
	53.38	16.78	A	*21.32	52.10	α-D
	49.34	21.41	A	17.54	53.19	"
	45.57	26.61	A	13.81	43.39	"
CNS	44.09	29.16	A	10.46	55.68	"
	43.00	31.39	A	7.90	56.67	"
	43.00	32.21	A + B	5.23	57.71	"
	43.56	31.66	B	2.10	58.99	"
	42.84	32.11	B	0.0	60.20	"
	42.07	32.81	B	*13.76	54.56	β-D
	41.12	33.69	B	*10.56	55.89	"
	40.22	34.22	B	*6.40	57.63	"
	39.06	35.22	B	*4.68	58.60	"
	36.89	37.18	B	*2.77	59.55	"
	36.28	37.47	B + C	*0.0	61.10	"
	*34.17	39.59	B	*0.0	60.75	"
	*33.53	40.00	B	*43.75	33.61	A + E
	*31.50	41.61	B	*41.83	35.31	E
	*43.88	32.56	A + C	*40.38	36.34	E
	*42.81	33.38	C	*36.74	39.52	E
	*41.91	34.61	C	*32.60	43.96	E
	*38.80	36.01	C	*20.05	48.50	E
	35.39	37.95	C	*28.30	49.57	E + F
	32.56	40.17	C	*28.49	49.20	F
	26.55	44.66	C	*25.26	50.82	F
				*23.46	52.14	β-D + F

A = KSCN

B = 3KSCN·Ca(SCN)₂·3H₂OC = 2KSCN·Ca(SCN)₂·3H₂Oα, β-D = Ca(SCN)₂·4H₂OE = Solid Solution Approaching 4KSCN·Ca(SCN)₂·
2H₂OF = Ca(SCN)₂·2H₂O

* = Metastable.

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE -
SODIUM THIOCYANATE - WATER AT 25°

(McKerrow, Occleshaw, and Drabble, 1946)

Gms. NaSCN per 100 gms. Sat. Sol.	Gms. Ca(SCN) ₂ per 100 gms. Sat. Sol.	Solid Phase
58.78	0.0	NaSCN·2H ₂ O
52.08	7.19	"
45.37	15.97	"
42.98	19.00	"
42.90	19.09	NaSCN·2H ₂ O + NaSCN
*62.42	0.0	NeSCN
*51.47	10.43	"

*Metastable

(Cont.)

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE -
SODIUM THIOCYANATE - WATER AT 25°—Cont.

Gms. NaSCN per 100 gms. Sat. Sol.	Gms. $\text{Ca}(\text{SCN})_2$ per 100 gms. Sat. Sol.	Solid Phase
*59.58	11.50	NaSCN
*43.83	18.14	"
41.74	20.59	"
38.82	23.13	"
37.91	24.07	"
32.38	29.71	"
29.32	32.45	"
22.40	39.91	"
21.32	41.06	"
19.57	43.27	"
16.36	46.46	"
14.14	49.67	"
11.15	53.03	"
11.10	53.52	"
9.88	54.48	NaSCN + $\text{Ca}(\text{SCN})_2 \cdot 4\text{H}_2\text{O}$
8.78	55.11	$\text{Ca}(\text{SCN})_2 \cdot 4\text{H}_2\text{O}$
5.11	57.57	"
3.09	58.49	"
0.0	60.20	"

CMS

*Metastable

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE -
AMMONIUM THIOCYANATE - WATER AT 25°
(McKerrow, Occleesshaw, and Drabble, 1946)

Gms. NH_4SCN per 100 gms. Sat. Sol.	Gms. $\text{Ca}(\text{SCN})_2$ per 100 gms. Sat. Sol.	Solid Phase
64.33	0.0	NH_4SCN
57.85	7.29	"
49.18	16.70	"
42.72	23.62	"
40.38	27.52	"
37.84	34.00	"
37.67	37.01	$\text{NH}_4\text{SCN} + 4\text{NH}_4\text{SCN}.$ $\text{Ca}(\text{SCN})_2 \cdot 2\text{H}_2\text{O}$
36.98	37.36	$4\text{NH}_4\text{SCN} \cdot \text{Ca}(\text{SCN})_2 \cdot 2\text{H}_2\text{O}$
35.04	39.04	"
34.35	39.49	"
34.13	40.19	"
32.89	41.58	"
31.48	43.22	"
31.37	43.29	"
29.04	45.33	"
28.15	46.24	"
26.87	47.29	"
25.95	49.07	"
25.50	49.89	{ $4\text{NH}_4\text{SCN} \cdot \text{Ca}(\text{SCN})_2 \cdot 2\text{H}_2\text{O} +$ $7\text{NH}_4\text{SCN} \cdot 6\text{Ca}(\text{SCN})_2 \cdot 12\text{H}_2\text{O}$

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM THIOCYANATE - AMMONIUM THIOCYANATE - WATER AT 25°--Cont.

	Gms. NH_4SCN per 100 gms. Sat. Sol.	Gms. $\text{Ca}(\text{SCN})_2$ per 100 gms. Sat. Sol.	Solid Phase
	25.55	50.13	$\{4\text{NH}_4\text{SCN} \cdot \text{Ca}(\text{SCN})_2 \cdot 2\text{H}_2\text{O} +$
	24.45	50.99	$7\text{NH}_4\text{SCN} \cdot 6\text{Ca}(\text{SCN})_2 \cdot 12\text{H}_2\text{O} +$
	23.31	51.62	$7\text{NH}_4\text{SCN} \cdot 6\text{Ca}(\text{SCN})_2 \cdot 12\text{H}_2\text{O}$
	21.38	52.76	"
CNS	20.55	53.26	"
	18.40	53.95	"
	*16.91	55.22	"
	17.32	55.64	" + $\text{Ca}(\text{SCN})_2 \cdot 4\text{H}_2\text{O}$
	15.23	55.11	$\text{Ca}(\text{SCN})_2 \cdot 4\text{H}_2\text{O}$
	9.29	57.14	"
	0.0	60.20	"
*metastable			

CN CALCIUM FERROCYANIDE $\text{Ca}_2\text{Fe}(\text{CN})_6$

SOLUBILITY OF CALCIUM FERROCYANIDE IN WATER (Farrow, 1926, 1927)

t°	Density of sat. solution	Gms. $\text{Ca}_2\text{Fe}(\text{CN})_6$ per 100 gms. sat. sol.	Solid Phase
-10.1 Eutec.	1.198	30.45	$\text{Ice} + \text{Ca}_2\text{Fe}(\text{CN})_6 \cdot 11\text{H}_2\text{O}$
24.9	1.3563	36.44	$\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot 11\text{H}_2\text{O}$
34.9	1.3662	39.22	"
49.8	1.3970	42.04	"
59.7	....	44.2	" + $\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
64.7	1.4074	44.44	$\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
90.0	1.401	44.4	"

SOLUBILITY OF CALCIUM FERROCYANIDE IN AQUEOUS SOLUTIONS OF SODIUM FERROCYANIDE AND VICE VERSA (Farrow, 1927)

d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	$\text{Ca}_2\text{Fe}(\text{CN})_6$	$\text{Na}_4\text{Fe}(\text{CN})_6$	
	Results at 25°		
1.356	37.16	0.0	$\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot 11\text{H}_2\text{O}$
1.369	35.27	3.67	"
1.373	35.10	4.79	"
1.381	33.24	7.55	" + $\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
...	31.45	8.60	$\text{Na}_2\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O} + "$
1.344	28.02	9.64	$\text{Na}_2\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O}$
...	22.22	11.50	"
1.130	0.0	17.05	"

(Cont.)

SOLUBILITY OF CALCIUM FERROCYANIDE IN AQUEOUS SOLUTIONS OF
SODIUM FERROCYANIDE AND VICE VERSA--Cont.

d. of Sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	$\text{Ca}_2\text{Fe}(\text{CN})_6$	$\text{Na}_4\text{Fe}(\text{CN})_6$	
Results at 50°			
1.392	42.2	0.0	$\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot 11\text{H}_2\text{O}$
...	40.51	2.91	"
1.437	40.00	2.91	" + $\text{CaNa}_2\text{Fe}(\text{CN})_6$
1.363	33.08	6.50	$\text{CaNa}_2\text{Fe}(\text{CN})_6$
1.332	24.40	12.90	"
1.314	20.05	16.24	"
1.310	17.8	18.31	" + $\text{Na}_4\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O}$
1.280*	9.53	25.25	"
1.300	16.26	18.65	$\text{Na}_2\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O}$
1.296	15.57	19.37	"
1.281	13.18	20.10	"
1.255	9.13	22.11	"
1.200	0.0	26.20	"
Results at 90°			
1.401	44.40	0.0	$\text{CaFe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
...	42.42	3.12	" + $\text{Na}_2\text{Fe}(\text{CN})_6$
1.335	34.74	5.02	$\text{Na}_2\text{Fe}(\text{CN})_6$
1.307	29.09	8.08	"
1.307	21.34	13.09	"
1.249	16.64	16.28	"
1.238	11.72	20.39	"
1.241	6.52	26.77	"
1.256	3.83	31.36	"
1.284	2.21	35.77	"
1.286	1.72	36.97	" + $\text{Na}_4\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
1.288	1.37	37.35	$\text{Na}_4\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$
1.290	0.0	38.00	"

* = unstable equilibrium.

CALCIUM Potassium FERROCYANIDE $\text{CaK}_2\text{Fe}(\text{CN})_6$

CN

CALCIUM Ammonium FERROCYANIDE $\text{Ca}(\text{NH}_4)_2\text{Fe}(\text{CN})_6$

CALCIUM Rubidium FERROCYANIDE $\text{CaRb}_2\text{Fe}(\text{CN})_6$

SOLUBILITY OF EACH IN WATER

(1) Kunheim and Zimmerman, 1884. (2) Brown, 1907. (3) Diaz de Rada and Bermejo, 1929.

t°	Gms. per 100 gms. H_2O		
	$\text{CaK}_2\text{Fe}(\text{CN})_6$	$\text{Ca}(\text{NH}_4)_2\text{Fe}(\text{CN})_6$	$\text{CaRb}_2\text{Fe}(\text{CN})_6$
15	0.125 (1)	...	...
15-17	0.41 (2)	0.258 (2)	...
20	0.500 (3)	...	...
22	...	0.298 (3)	0.059 (3)
100	0.69 (1)	...	...

Ca CALCIUM

SOLUBILITY IN SALT SOLUTIONS

Tananaev and Tikhomirova (1945) determined the solubility of $K_2CaFe(CN)_6$ in solutions of KCl, $K_4Fe(CN)_6$ and $Ca_2Fe(CN)_6$ [all decrease the solubility], and in LiCl [increases the solubility].

SOLUBILITY OF EACH SEPARATELY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL (Díaz de Rada and Bermejo, 1929)

CN	Results for $CaK_2Fe(CN)_6$ at 20°		Results for $Ca(NH_4)_2Fe(CN)_6$ at 22°		Results for $CaRb_2Fe(CN)_6$ at 22°	
	Wt. percent C_2H_5OH in solvent	Gms. $CaK_2Fe(CN)_6$ per 100 gms. sat. sol.	Wt. percent C_2H_5OH in ssolvent	Gms. $Ca(NH_4)_2Fe(CN)_6$ per 100 gms. sat. sol.	Wt. percent C_2H_5OH in solvent	Gms. $CaRb_2Fe(CN)_6$ per 100 gms. sat. sol.
	0.0 ($=H_2O$)	0.498	0.0 ($=H_2O$)	0.297	0.0 ($=H_2O$)	0.059
	5.0	0.344	5.0	0.240	5.0	0.050
	10.0	0.209	10.0	0.171	10.0	0.035
	15.0	0.136	15.0	0.115	15.0	0.026
	20.0	0.092	20.0	0.076	20.0	0.016
	25.0	0.054	25.0	0.52	25.0	0.010
	30.0	0.035	30.0	0.31	35.0	0.000
	40.0	0.019	40.0	0.012		

CO CALCIUM CARBONATE $CaCO_3$

SOLUBILITY IN WATER

Since the reactions $CO_3^{2-} \rightleftharpoons HCO_3^-$ and $HCO_3^- \rightleftharpoons CO_2$ aq. are appreciable, the solubility of $CaCO_3$ is dependent on the concentration of CO_2 in solution, and therefore on the partial pressure of CO_2 in the atmosphere above the solution.

Much of the older work has been evaluated by Johnston (1915) and Frear and Johnston (1929) and only data representing some of the more reliable results are reproduced here. For additional (older) data see:

Cossa, 1869; Schloesing, 1872; Caro, 1874; Reid, 1887-88;
Irving and Young, 1888; Anderson, 1888-89; Engel, 1888;
Lubavin, 1892; Pollacci, 1896; Leather and Sen, 1909; Cavazzi,
1917; Seyler and Lloyd, 1909; Holleman; Treadwell and Renter,
1896; Ramann and Sallinger, 1921.

SOLUBILITY OF CALCIUM CARBONATE IN WATER IN CONTACT WITH ORDINARY AIR (Wells, 1915)

Joplin, Mo., calcite was used. The solutions were kept in a thermostat and agitated by a current of out-door air filtered through cotton and washed by water. The CO_2 content of the air varied from 3.02 to 3.27 parts per 10,000. The calcium content of the solutions was determined by titrating with 0.02 N $NaHSO_4$, using methyl orange as indicator. The solutions were slightly acid to phenolphthalein, showing that the calcium was present chiefly as bicarbonate.)

(Cont.)

SOLUBILITY OF CALCIUM CARBONATE IN WATER IN
CONTACT WITH ORDINARY AIR--Cont.

Results in parentheses are by Kendall (1912). In connection with these it is stated by Johnston (1915), that assurance is wanting that the partial pressure of CO_2 was the same at both temperatures and the results are, therefore, not necessarily comparable.

t°	Gms. CaCO_3 per Liter	t°	Gms. CaCO_3 per Liter
0	0.081	30	0.052
10	0.070	40	0.044
20	0.065	50	0.038 (0.029)
25	0.056 (0.046)		
	0.052*		

CO

*Frear and Johnston, 1929.

SOLUBILITY OF CALCIUM CARBONATE IN WATER ESSENTIALLY
FREE OF CARBON DIOXIDE

t°	Gms. CaCO_3 per liter	Author
15	0.238 (?)	Treadwell and Renter, 1896
17	0.0145	Stumper, 1925
18	0.0128	LeBlanc and Novotny, 1906
25	0.0132	Franquin and Marecaux, 1938
25	0.013	Askev, 1923
"Room t°"	0.013	Wesley, 1944
95	0.024	"
95-100	0.0207	LeBlanc and Novotny, 1906
100	0.0375	Leick, 1932, 1933
182	0.025	Straub, 1932
207	0.014	"
244	0.011	"
316	0.08	"
370	0.39 (200 atm.)	Schleomer, 1952

SOLUBILITY OF CALCIUM CARBONATE IN WATER
AT LOW PARTIAL PRESSURES OF CO_2

THE SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER AT 16° IN
CONTACT WITH AIR CONTAINING PARTIAL PRESSURE P OF CO_2
(Calc. from Schloesing, 1872, and Engel, 1888, by Johnston, 1915)

Partial Pressure P of CO_2 in Atmospheres	Total Ca. Mols. per Liter	Total $\text{Ca}(\text{HCO}_3)_2$ Mols. per Liter
0.000504	0.000746	0.000731
0.000808	0.000850	0.000837
0.00333	0.001372	0.001364
0.01387	0.002231	0.002226
0.02820	0.002965	0.002961
0.05008	0.003600	0.003597
0.1422	0.005330	0.005328
0.2538	0.006634	0.006632
0.4167	0.007825	0.007874
0.5533	0.008855	0.008854
0.7297	0.009772	0.00972

(Cont.)

Ca CALCIUM

THE SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER AT 16° IN CONTACT WITH AIR CONTAINING PARTIAL PRESSURE P OF CO₂--Cont.

Partial Pressure P of CO ₂ in Atmospheres	Total Ca. Mols. per Liter	Total Ca(HCO ₃) ₂ Mols. per Liter
0.9841	0.01086	0.01086
1	0.01085	0.01085
2	0.01411	0.01411
4	0.01834	0.01834
6	0.02139	0.02139

CO

EQUILIBRIUM IN THE SYSTEM CaO-H₂O-CO₂ AT 16°

The following data for the solubility of calcite (CaCO₃) in water at 16° in contact with air containing the partial pressure P of CO₂ were calculated from the results of Schloesing (1872), Engel (1888), and others by Johnston (1915) and Johnston and Williamson (1916). These authors describe the changes in the system resulting from a gradual increase in partial pressure of CO₂, as follows:

"We begin by considering the equilibrium between the hydroxide M(OH)₂ and the aqueous solution saturated with it as affected by a progressive increase from zero of the partial pressure P of CO₂ in the atmosphere in contact with the solution. Addition of CO₂ is followed by a distribution between the vapor and liquid phases until there is equilibrium between the residual partial pressure of CO₂ and the H₂CO₃ in solution, and in turn between the latter and the several ions; the net effect of this is a definite decrease in [OH⁻], the concentration of hydroxide ion, which necessitates that more of the hydroxide dissolve in order to keep the solubility-product [M⁺⁺][OH⁻]² constant. Consequently the total concentration of M⁺⁺ increases, part of it being now associated with carbonate and bicarbonate; in other words, the apparent solubility of the base increases if the method of analysis of the solution is a determination of M, whereas it would decrease if one should determine [OH⁻]². This process continues until the product [M⁺⁺][CO₃⁼] reaches the value requisite for the precipitation of MCO₃ (on the assumption that supersaturation does not occur) which, for a given base, takes place at a definite value of P which depends only upon the temperature; this transition pressure P₁ is, at a given temperature, the highest under which solid hydroxide is stable and the lowest at which solid carbonate is stable.

At P₁ the solubility (as measured by the total [M]) begins to diminish, because increase of P increases [CO₃⁼] while the product [M⁺⁺][CO₃⁼] must remain constant so long as MCO₃ is the stable solid phase; this increase of [CO₃⁼] continues until a definite pressure P₀ is reached, when the formation of bicarbonate in the solution becomes the predominant reaction and [CO₃⁼] begins to decrease again. P₀ is thus a minimum in the solubility curve. With further increase beyond P₀ the concentration of both M⁺⁺ and HCO₃⁻ increases steadily until the precipitation value of the product [M⁺⁺][HCO₃⁻]² is reached at P₂, which is a transition pressure at which both carbonate and bicarbonate are present as stable solid phases. Beyond P₂ bicarbonate alone is stable, and its total solubility falls off very slowly with further increase of partial pressure of CO₂."

EQUILIBRIUM IN THE SYSTEM $\text{CaO-H}_2\text{O-CO}_2$ AT 16° —Cont.

The Calculated Ion-Concentrations and Solubility of Calcite in Water at 16° in Contact with Air Containing the Partial Pressure P of CO_2 .

Partial Pressure P of CO_2 Measured in Atmospheres	Ion-concentrations per Liter $\times 10^{-1}$				Total Ca, Mola. per Liter $\times 10^{-4}$	Grams CaCO_3 , per Liter
	Ca^{++}	OH^-	CO_3^{--}	HCO_3^-		
3.16×10^{-14}	138.5	277	0.0071	0.0000235	..	2.000
2.80×10^{-10}	6.81	13.3	0.144	0.01	..	0.074
9.78×10^{-9}	2.377	3.82	0.414	0.10	..	0.026
6.14×10^{-8}	1.654	1.82	0.593	0.30	..	0.018
2.10×10^{-7}	1.476	1.02	0.665	0.60	..	0.016
3.73×10^{-7}	1.459	0.787	0.672	0.787	..	0.0159
3.85×10^{-7}	1.459	0.774	0.672	0.80	..	0.0159
6.07×10^{-7}	1.473	0.614	0.666	1	..	0.016
7.62×10^{-6}	2.051	0.147	0.478	3	..	0.022
7.63×10^{-5}	3.777	0.034	0.260	7	..	0.040
2.15×10^{-4}	5.197	0.0174	0.188	10	..	0.056
2×10^{-4}	5.09	0.0182	0.19	9.76	5.52	0.055
2.5×10^{-4}	5.46	0.0157	0.18	10.54	5.93	0.059
3×10^{-4}	5.79	0.0140	0.17	11.22	6.31	0.063
3.5×10^{-4}	6.08	0.0126	0.16	11.82	6.64	0.066
4×10^{-4}	6.35	0.0115	0.16	12.36	6.94	0.069
4.5×10^{-4}	6.59	0.0107	0.15	12.86	7.21	0.072
5×10^{-4}	6.82	0.0100	0.14	13.32	7.46	0.075

THE EQUILIBRIUM CONSTANTS FOR AQUEOUS SYSTEMS CONTAINING
CALCIUM CARBONATE AND OTHER SALTS AT 38°
(Kugelmass and Shohl, 1924)

The authors determined the equilibrium constants for the systems
(1) $\text{CaCO}_3 + \text{Ca}(\text{HCO}_3)_2 + \text{CO}_2$, (2) $\text{CaCO}_3 + \text{Ca}(\text{HCO}_3)_2 + \text{NaHCO}_3 + \text{CO}_2$ and
(3) $\text{CaCO}_3 + \text{Ca}(\text{HCO}_3)_2 + \text{CaHPO}_4 + \text{Ca}(\text{H}_2\text{PO}_4)_2 + \text{CO}_2$. The CO_2 tensions
varied from 17 to 110 mm. The several constants are discussed in con-
nection with similar values previously obtained by others.

THE SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER AT 25°
IN PRESENCE OF CARBON DIOXIDE AT PRESSURES
VARYING FROM 0.0003 TO 1.0 ATMOSPHERES
(Frear and Johnston, 1929)

By means of a plot of the available data published between 1916 and
1929 the following values were obtained.

Partial Pressure of CO_2 in Atmos.	0.00032	0.001	0.01	0.1	1.0	10.
Millimols CaCO_3 per kg. H_2O	0.53	0.78	1.7	3.9	9.0	22.5

"The temperature coefficient of the solubility is, within the ac-
curacy of the measurements, independent of the partial pressure of carbon
dioxide, particularly in the range 0.0003 to 1. atm.; consequently it
suffices to give the ration r of the solubility at t° to that at 25° ."

t°	0°	10°	20°	25°	30°	50°
r	1.8	1.4	1.1	1.0	0.9	0.6

These values of r are on the line $\log r = 830/T - 2.78$; this formula
when extrapolated to 100° yields results in harmony with analyses of
waters from boilers.

Ca CALCIUM

REDETERMINATIONS OF THE SOLUBILITY OF CALCITE IN WATER AT 25°. (W. D. Kline) (Frear and Johnston, 1929)

Partial pressure of CO ₂ in Atm.	Milligram mols. per 1000 gms. H ₂ O	
	Calcium 1000 [Ca ⁺⁺]	Bicarb 1000 [HCO ₃ ⁻]
0.00031	0.52	1.02
0.00038	0.56	1.10
0.00093	0.76	1.50
0.00334	1.17	2.32
0.00690	1.51	3.01
0.0160	2.01	4.01
0.0432	2.87	5.74
0.1116	4.03	8.06
0.9684	8.91	17.82

SOLUBILITY OF CALCIUM CARBONATE IN WATER AT HIGH PRESSURES (Haehnel, 1924; Mitchell, 1923; McCoy and Smith, 1911)

In the case of the determinations by Haehnel the mixture was contained in a glass vessel placed inside an autoclave which was shaken six times per hour. By inverting the autoclave the saturated solution was filtered through a thimble into a receiver. Thus the entire operation was conducted at the selected pressure of CO₂. The stability limit at 18° is at 35-40 atmospheres pressure. Different kinds of CaCO₃ gave essentially the same results. Equilibrium was approached from above in each case since saturation was first effected at 56 atmospheres pressure and the pressure successively reduced and aliquots withdrawn for analysis. The author also used another apparatus provided with an electrically driven stirrer.

In the case of the determinations by Mitchell a steel bulb, provided with an inner silver lining, was employed. The suspension of the finely divided calcite was stirred by a stream of gas passing through the liquid at the given pressures. The sat. solution was forced out by pressure through a filter of cotton wool. The entire apparatus was kept in an oil bath maintained at 25°. No neutral carbonate was present since in all cases the molecular ratio of CO₂ to Ca in solution, was greater than 2:1. This author also gives results for the solubility of mixtures of calcite and magnesium carbonate trihydrate, and for Algerian dolomite in water containing various pressures of CO₂ at 25°.

The results of McCoy and Smith show that the solution becomes saturated with Ca(HCO₃)₂ at about 15 atmospheres pressure of CO₂, and it would be theoretically possible to convert all the CaCO₃ to Ca(HCO₃)₂ by introducing sufficient CO₂ at pressures greater than 15 atmospheres. Under the conditions of the present experiment, it was calculated that more than 3 months time would have been required for the complete conversion. Mitchell and McCoy and Smith also give the CO₂ content of the solutions.

SOLUBILITY OF CALCIUM CARBONATE IN WATER AT HIGH PRESSURES—Cont.

Atmospheres Pressure of CO ₂	18° (Haehnel, 1924) gms. CaCO ₃ per 1000 gms. sat. sol.		25° Gms. CaCO ₃ per liter sat. sol.	
			Mitchell, 1923	McCoy and Smith, 1911
0.1	..	..	..	0.412
1	1.08	..	..	...
1.1	..	..	..	.974
2	1.40	..	..	...
4	1.82	1.80	...	...
6	2.11	1.95	...	...
8	..	2.13	...	...
9.9	..	..	2.238	...
10	2.56	2.3	...	...
12	..	2.5	...	...
13.2	..	..	2.497	...
14	2.83	2.65	...	...
16	..	2.67	...	...
16.3	..	..	2.603*	...
18	3.07	2.67	...	...
18	..	2.67	...	...
24	..	2.674	...	...
25	3.42	..	...	...
25.4	..	..	2.606*	...
35	3.80	..	...	...
56	3.93	..	...	...
56	4.03 (25°)			
56	3.80 (35°)			
56	3.39 (45°)			
56	2.55 (55°)			

*Solid phase Ca(HCO₃)₂.SOLUBILITY OF CALCITE AT VARIOUS TEMPERATURES AND PRESSURES OF CO₂
(Miller, 1952)

The determinations were made on optical grade calcite and the measurements were made by the loss in weight of plates of the material. The bombs were made of Allegheny metal.

Similar data are given where Solenhofen limestone and Venus mercenaria shells were used in place of calcite. At pressures greater than 10 bars at 0°, and 50 bars at 25°, carbon dioxide hydrate (CO₂·8H₂O) was formed. The values in the table were read from the curves drawn by the author through many points. They are self consistent, but in only fair agreement with the data of other workers.

t°	Grams CaCO ₃ per liter - partial pressure CO ₂ in bars -					
	1	10	20	40	50	100
0	1.34	2.46	..	..	..	..
10	1.11	2.15	..	..	..	..
20	0.91	1.88	2.33	2.81	..	..
25	.82	1.75	2.16	2.62	2.85	..
30	.72	1.63	2.01	2.44	2.62	..

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCITE AT VARIOUS TEMPERATURES AND PRESSURES OF CO₂--Cont.

		Grams CaCO ₃ per liter				
		- partial pressure CO ₂ in bars -				
t°	1	10	20	40	50	100
40	0.55	1.39	1.73	2.08	2.22	2.51
50	.43	1.17	1.46	1.74	1.86	2.15
60	.36	0.97	1.22	1.44	1.56	1.80
70	.30	.79	0.99	1.20	1.30	1.49
80	.26	.66	.83	1.01	1.08	1.24
90	.23	.58	.70	0.85	0.90	1.04
100	.20	.52	.61	.71	.77	0.88
CO 105	.19	.49	.53	.66	.71	.81

COMPARISONS OF THE SOLUBILITY OF CALCITE AND ARAGONITE

Results of Björkström, 1921

The aragonite was prepared by heating in a sealed tube to 140°, a 1.0 molecular solution of CaCl₂ (sat. with CO₂) and urea. It contained 0.5% calcite and 0.6% urea. The calcite was obtained by grinding Iceland spar and removing all particles smaller than 10 μ by decanting with conductivity water. Equilibrium was not reached with calcite because of the extremely small velocity of the reaction. The most likely values are given.

Results for Aragonite

t°	Pressure of CO ₂	Sp. conductivity x 10 ⁻³	Gm. equiv. CaCO ₃ per liter	Gm. CaCO ₃ per liter
9	777 ^{mm}	1.534	0.0291	1.46
25	762	1.723	0.0213	1.066
35	742	1.774	0.01751	0.876

Results for Calcite

t°	Pressure of CO ₂	Sp. conductivity x 10 ⁻³	Gm. equiv. CaCO ₃ per liter	Gm. CaCO ₃ per liter
9	777 ^{mm}	1.39	0.0260	1.30
25	762	1.547	0.01834	0.943
35	742	1.573	0.01529	0.765

Results of Bowman and Hastings, 1937

The authors give data for the solubility of Aragonite in aqueous sodium chloride solutions at 38°, containing CO₂ in amounts such that the pH at equilibrium varied between 7.2 and 7.6. These results when compared with similar determinations upon Calcite showed that Aragonite is more soluble than Calcite, the ratio of their solubility products being 1.41.

SOLUBILITY OF CALCIUM CARBONATE OF DIFFERENT ORIGINS AND FINENESS
IN WATER CONTAINING CARBON DIOXIDE
(Hager and Kern, 1916-1920)

The authors show that the degree of fineness influences greatly the velocity of solution of calcium carbonate in water containing CO_2 . The shorter the period of action, the more pronounced are the differences observed. The variations increase with increase of CO_2 in the water.

SOLUBILITY OF MIXTURES OF CALCIUM CARBONATE (CALCITE) AND OF CALCIUM
SULFATE (GYPSUM) IN WATER AT 25° AND PARTIAL PRESSURE P OF CARBON DIOXIDE
(Frear and Johnston, 1929)

Partial pressure of CO_2 in Atm. P	Milligram mols. per 1000 gms. H_2O		Partial pressure of CO_2 in Atm. P	Milligram mols. per 1000 gms. H_2O	
	1000	1000		1000	1000
	$\text{Ca}(\text{HCO}_3)_2$	CaSO_4		$\text{Ca}(\text{HCO}_3)_2$	CaSO_4
0.121	3.11	14.43	0.897*	7.40	13.60
0.167*	3.56	14.24	0.916*	7.53	13.41
0.270	4.34	13.99	0.957	7.51	13.20
0.431	5.31	13.48	0.963	7.55	13.20
0.598	6.22	13.25	0.960	7.55	12.98
0.652	6.42	13.27	0.953	7.58	13.17
0.728*	6.71	13.41	0.966	7.85	8.51
0.700*	6.95	13.46	0.962	8.30	4.13

CO

The determinations marked * were made in an apparatus in which a mixture of air and CO_2 was made to pass continually through the system by means of a motor driven mercury circulating pump. The others were made in a special form of apparatus which permitted the solution to pass repeatedly back and forth through a filter containing the solid phase, so that the movement of the liquid provides the pump action for circulating the gas. In the case of the last two results in the table the solutions were not saturated with respect to calcium sulfate.

SOLUBILITY OF MIXTURES OF CALCIUM CARBONATE AND CALCIUM
SULFATE (ANHYDRITE) IN WATER AT HIGH TEMPERATURES
(Clark and Hunter, 1935)

The determinations were made in connection with the study of Scale formation from boiler waters. A two liter steel rotary converter (bomb) heated by a gas burner was used. The temperature was measured with a calibrated chromel-alumel couple. The samples were withdrawn through a copper capillary cooling coil. Total solids were determined by evaporation and weighing the deposit after drying at 150°.

Gms. per 1000 gms. H_2O					Gms. per 1000 gms. H_2O				
t*	Total solids	Ca	SO_4	CO_3	t*	Total solids	Ca	SO_4	CO_3
159	0.210	0.058	0.131	0.006	206	0.075	0.022	0.0359	0.011
159	0.208	0.060	0.128	0.012	225	0.048	...	0.0216	0.009
178	0.139	0.041	0.076	0.013	241	0.040	...	0.0146	0.008
195	0.095	0.028	0.046	0.013	252	0.032	...	0.0117	0.008

(Cont.)

Ca CALCIUM

SOLUBILITY OF MIXTURES OF CALCIUM CARBONATE AND CALCIUM SULFATE (ANHYDRITE) IN WATER AT HIGH TEMPERATURES--Cont.

The authors also give similar determinations for the solubility of CaCO_3 + CaSO_4 in aqueous solutions of Na_2SO_4 , Na_2CO_3 , NaCl and NaOH . The results show that the ratio of CO_3/SO_4 is greatly reduced by sodium sulfate and much less so by sodium chloride. Sodium hydroxide increases the sodium sulfate concentration at equilibrium and thus also reduces the CO_3/SO_4 ratio.

THE SYSTEM CaCO_3 - CaSO_4 - NaCl - CO_2 - H_2O AT 25°
(Shternina and Frolova, 1945)

CO

The system was studied at two pressures of Carbon Dioxide with varying amounts of NaCl added. The solid phases were always CaCO_3 (Calcite) or $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (Gypsum); or a mixture of the two.

Solid Phase	Gms. $\text{Ca}(\text{HCO}_3)_2$ per 1000 gms. H_2O	Gms. CaSO_4 per 1000 gms. H_2O	Gms. NaCl per 1000 gms. H_2O	Partial Pressure CO_2 (Atm.)	Density $\frac{22}{4}$
Calcite	1.478	0.0	0.0	0.9555	0.9989
"	1.621	0.0	2.500	.9639	1.007
"	1.723	0.0	5.027	.9593	1.0026
"	1.913	0.0	10.204	.9658	1.0065
"	2.073	0.0	15.000	.9645	1.0101
"	2.195	0.0	20.486	.9671	1.0141
Gypsum	0.0	2.091	0.0	.9632	0.9993
"	0.0	2.450	2.500	.9750	1.0013
"	0.0	2.916	5.001	.9777	1.0034
"	0.0	3.429	10.145	.9711	1.0077
"	0.0	3.884	15.002	.9750	1.0114
"	0.0	4.356	20.013	.9687	1.0153
Calcite + Gypsum	1.258	1.739	0.0	.9726	0.9999
" "	1.475	2.258	2.526	.9653	1.0023
" "	1.580	2.533	5.076	.9782	1.0044
" "	1.614	3.053	10.133	.9597	1.0084
" "	1.652	3.496	15.206	.9517	1.0124
" "	1.736	4.005	20.228	.9684	1.0165
Calcite	0.129	0.0	0.0	.0013	0.9968
Gypsum	0.0	2.096	0.0	"	0.9987
Calcite + Gypsum	0.040	2.244	0.0	"	0.9991
Calcite	0.194	0.0	10.278	"	1.0042
Gypsum	0.0	3.505	10.278	"	1.0074
Calcite + Gypsum	0.050	3.598	10.285	"	1.0071
Calcite	0.243	0.0	20.350	"	1.0113
Gypsum	0.0	4.414	20.125	"	1.0155
Calcite + Gypsum	0.061	4.509	20.085	"	1.0151

Data for the solubility of mixtures of calcium carbonate and calcium sulfate in aqueous solutions of sodium chloride at 25° are given by Cameron and Seidell (1901).

Data for the solubility of mixtures of calcium carbonate and calcium sulfate in aqueous solutions of mixtures of sodium chloride and sodium sulfate at 25° , in contact with air and with CO_2 , are given by Cameron, Bell and Robinson (1907).

THE SYSTEM $\text{CaCO}_3 - \text{MgCO}_3 - \text{H}_2\text{O}$

The system is reported in detail by Yanat'eva, 1950, 1954, 1954a, 1955. The older work of Halla, and Freer and Johnson, 1929, 1933 are in fair agreement. In Yanat'eva's 1950 paper, extensive data on the solubility of CaCO_3 , MgCO_3 , and Dolomite in 1% and 2% NaCl solutions are given. Shternina and Frolova (1945) also give results in the presence of NaCl. Most of the work has been done at 1 atmosphere of CO_2 . The analyses of solutions saturated with natural limestones (Sveshnikova, 1952) are in agreement with the following data.

Results of Yanat'eva at 1 atm. CO_2 D = Dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$)

CO

Millimols per 1000 g. sat. sol.			millimoles per 1000 g. sat. sol.		
Ca	Mg	Solid Phase	Ca	Mg	Solid Phase
Results at 0°			Results at 55°		
15.08	0.0	CaCO_3	6.09	0.0	CaCO_3
13.64	1.32	$\text{CaCO}_3 + \text{D}$	4.23	2.17 (pH 6.69)	$\text{CaCO}_3 + \text{D}$
5.34	5.40	D	3.00	3.08	D
3.40	12.27	D + MgCO_3	2.15	7.39 (pH 6.92)	D + MgCO_3
0.0	22.52	MgCO_3	0.0	15.59	MgCO_3
Results at 25°			Results at 70°		
8.98	0.0	CaCO_3	3.45	0.0 (pH 7.66)	CaCO_3
8.10	1.18 (pH 5.8)	$\text{CaCO}_3 + \text{D}$	2.03	2.55 (pH 7.82)	$\text{CaCO}_3 + \text{D}$
3.21	3.28 (pH 5.7)	D	1.55	5.89 (pH 7.84)	D + MgCO_3
2.50	11.26 (pH 6.0)	D + MgCO_3	D = $\text{CaCO}_3 \cdot \text{MgCO}_3$		
0.0	16.50	MgCO_3			

Results of Halla, 1935 at 1 atm. CO_2

Results at 25°

Results at 38°

millimoles per liter		Solid Phase	millimoles per liter		Solid Phase
Ca	Mg		Ca	Mg	
8.21	2.67	$\text{CaMg}(\text{CO}_3)_2 + \text{CaCO}_3$	6.03	2.20	$\text{CaMg}(\text{CO}_3)_2 + \text{CaCO}_3$
8.67	3.05	" + "	6.11	2.37	" + "
3.41	14.48	" + MgCO_3	6.26	2.48	" + "
3.73	12.08	" "	2.84	11.37	" + MgCO_3
0.30	211.2	" + $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$	2.56	10.84	" "
0.17	221.8	" "	0.237	150.9	" + $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$
			0.261	148.1	" "

Results of Yanat'eva at about 0.0012 atm. CO_2 at 25°millimoles per
1000 gms.
sat. sol.

Ca	Mg	pH	Solid Phase
0.81	0.0	..	CaCO_3
0.39	0.94	7.76	$\text{CaCO}_3 + \text{CaCO}_3 \cdot \text{MgCO}_3$
0.40	1.02	7.78	$\text{CaCO}_3 \cdot \text{MgCO}_3$
0.32	1.20	7.87	$\text{CaCO}_3 \cdot \text{MgCO}_3 + \text{MgCO}_3$
0.0	1.65	..	MgCO_3

Ca CALCIUM

SOLUBILITY OF DOLOMITE ($\text{CaCO}_3 \cdot \text{MgCO}_3$) IN WATER

t°	P _{CO₂}	Solubility		Author
0	1 atm.	10.74	mmol per 1000 g sol'n.	Yanat'eva, 1954a, 1955
25	0.0012 atm.	1.42	"	"
25	1 atm.	6.49	"	"
55	1 atm.	6.08	"	"
75	1 atm.	4.58	"	"
370*	? 200 atm. total press.	1.46	"	Schloemer, 1952

*The decomposition of dolomite to $\text{Mg}(\text{OH})_2 + \text{CO}_2$ occurs at 390°, 500 atm. and 300°, 3000 atm.

CO

Results are given by Leick (1932, 1933) simultaneous solubility of CaCO_3 and MgCO_3 at 100°, which show that the dissolved CaO increases about five times and the MgO decreased about ten times when the period of boiling is lengthened from 1½ to 48 hours. The author's experiments are of interest in connection with the purification of boiler waters.

THE QUATERNARY SYSTEM $\text{CaCO}_3 + \text{MgSO}_4 \rightleftharpoons \text{CaSO}_4 + \text{MgCO}_3$ AT 1 ATM. PARTIAL PRESSURE OF CO_2 (Yanat'eva, 1955a)

millimoles per 1000 gms. sat. sol.

Solid Phases	at 0°				at 55°			
	Ca	Mg	(HCO_3) ₂	SO ₄	Ca	Mg	(HCO_3) ₂	SO ₄
C	15.08	...	15.08	...	6.09	...	6.09	...
D	5.34	5.40	10.74	...	3.02	3.06	6.08	...
D + C	13.64	1.32	14.96	...	4.23	2.17	6.40	...
M	...	22.52	22.52	...	...	15.59	15.59	...
D + M	3.40	12.27	15.67	...	2.15	7.39	9.54	...
C + G	24.20	...	13.40	10.80	20.55	...	5.23	15.32
D + C + G	25.88	1.63	15.29	12.22	19.94	2.28	5.74	16.48
D + C + G	...	...	...	...	19.80	2.45	5.65	16.60
D + G	20.65	7.17	14.60	13.22	19.34	3.11	5.89	15.56
D + G	18.96	10.48	15.26	14.18	...	...	...	...
D + G	20.08	11.47	15.66	15.89	...	...	...	...
D + G + M	19.70	12.64	16.08	16.26	17.72	13.00	8.18	22.54
M + G	...	...	...	...	14.60	17.62	8.50	23.72
M + G	...	...	...	...	13.75	50.95	10.58	54.12
M + G	...	...	...	...	13.49	79.24	12.78	79.95
M + G	...	...	...	...	12.56	149.91	15.55	146.92
M + G	...	...	...	...	12.08	188.15	15.35	184.88

C = CaCO_3 M = MgSO_4 (.7H₂O at 25°)
D = $\text{CaCO}_3 \cdot \text{MgCO}_3$ G = $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (.6H₂O at 55°)

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM
HYDROXIDE IN CONTACT WITH CO₂ FREE AIR
(LeBlanc and Novotny, 1906)

Solvent	Gms. CaCO ₃ per Liter Sat. Sol.	
	At 18°	At 95°-100°
Water	0.0128	0.0207
About 0.0001 n NaOH	0.0087	0.0096
" 0.0010 n "	0.0042	0.0069
" 0.0100 n "	0.0042	0.0057

Data on the equilibrium in aqueous solutions of CaCO₃, Na₂CO₃ and CO NaOH are given by Wegscheider and Walter (1907).

THE SYSTEM CALCIUM CARBONATE - SODIUM CARBONATE - WATER

Results at 13°
(Pratolongo, 1924)

Gms. per liter of sat. sol.		Solid Phase
Na ₂ CO ₃	CaCO ₃	
0.0	0.013	Calcite-CaCO ₃
10.0	0.007	"
50.0	0.005	Gay Lussite-Na ₂ CO ₃ ·CaCO ₃ ·5H ₂ O
150.0	0.000	Na ₂ CO ₃ ·10H ₂ O

Results at 15, 20, 25, 30°
(Bury and Redd, 1933)

At the lower temperatures the three components were rotated in tubes for 7-14 days. At the higher temperatures they were stirred in a bottle fixed in a thermostat. The saturated solutions and solid phases were analyzed. The amount of CaCO₃ in the sat. solutions was too small to be determined.

t°	Gms. Na ₂ CO ₃ per 100 gms. sat. sol.	Solid Phase	t°	Gms. Na ₂ CO ₃ per 100 gms. sat. sol.	Solid Phase
15	8.91	C	25	14.65	C
"	12.10	C	"	15.81	C + G
"	14.11	C + G	"	16.49	G
"	14.12	G + D	"	18.03	G
"	16.78*	G	"	20.30	G
"	22.51*	G	"	22.63	G + D
20	14.81	C + G	"	19.84*	C
25	6.86	C	"	20.52*	C + P
"	12.33	C	"	21.14*	P

C = CaCO₃; G = Gaylussite, CaCO₃·Na₂CO₃·5H₂O; P = Pirssonite, CaCO₃·Na₂CO₃·2H₂O; D = Na₂CO₃·10H₂O; H = Na₂CO₃·7H₂O; M = Na₂CO₃·H₂O.
* denotes metastable equilibrium.

(Cont.)

Ca CALCIUM

THE SYSTEM CALCIUM CARBONATE - SODIUM CARBONATE - WATER--Cont.

Results at 15, 20, 25, 30°--Cont.

t°	Gms. Na ₂ CO ₃ per 100 gms.		Solid Phase	t°	Gms. Na ₂ CO ₃ per 100 gms.		Solid Phase
	sat.	sol.			sat.	sol.	
30	16.20		C	37.5	27.81*		P
"	17.42		C + G	"	31.37*		P
"	18.78		G	"	32.97		P + M
"	20.05*		C	39	21.26		C + G
"	20.90*		C + P	"	25.72		G + P
CO	21.68*		P	"	27.35		P
35	7.0		C	45	11.40		C
"	16.90		C	"	18.15		C
"	18.91		C	"	22.18		C + P
"	19.49		C + G	"	23.74		P
"	20.86		G	"	27.87		P
"	23.10		G	"	30.31		P
"	28.01		G	"	32.15		P
"	30.09		G	"	32.46		P + M
"	32.88		C + H	55	23.07		C + P
37.5	18.14		C	65	24.02		C + P
"	19.87		C	75	24.93		C + P
"	20.53		C + G	85	25.87		C + P
"	23.16		G	95	26.81		C + P
"	26.32		G	15	14.11		C + G + D
"	29.26		G	20.4			C + G + D
"	32.43		G + P	40.0	21.7		C + G + P
"	32.68		P	37.3	33.0		G + P + D
"	21.48*		C + P	103.2	27.5		C + P
"	24.62*		P				

C = CaCO₃; G = Geylussite, CaCO₃.Na₂CO₃.5H₂O; P = Pirssonite, CaCO₃.Na₂CO₃.2H₂O; D = Na₂CO₃.10H₂O; H = Na₂CO₃.7H₂O; M = Na₂CO₃.H₂O.

* denotes metastable equilibrium.

SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN AQUEOUS
SOLUTIONS OF SODIUM CHLORIDE AT 25°
(Frear and Johnston, 1929)

A stream of CO₂ was bubbled through the salt solution containing suspended CaCO₃. In solutions more concentrated than shown below equilibrium was not attained even after a week.

Partial pressure of CO ₂ in Atm. P	millimoles per 1000 gms. H ₂ O		Partial pressure of CO ₂ in Atm. P	millimoles per 1000 gms. H ₂ O	
	Ca(HCO ₃) ₂	NaCl		Ca(HCO ₃) ₂	NaCl
0.965	8.96	3.79	0.963	12.34	297.
0.965	9.37	14.8	0.953	14.73	599.
0.965	9.67	34.8	0.968	14.67	816.
0.962	10.70	82.8	0.955	15.55	878.
0.958	12.41	236.	0.953	14.55	1089.
			0.968	16.18	1154.

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM
CHLORIDE AT 25°

Note: The results of Cameron and co-workers are considered by Frear and Johnston, 1929, to be of only qualitative significance since the experimental conditions were insufficiently controlled.

Solutions in contact with:

CO ₂ Free Air (Cameron, Bell and Robinson, 1907) Gms. per 100 Gms. H ₂ O		Ordinary Air (Cameron and Seidell, 1902) Gms. per 100 cc. Sat. Sol.		CO ₂ at One Atmos. Pressure (Cameron, Bell and Robinson, 1907) Gms. per 100 Gms. H ₂ O		CO
NaCl	CaCO ₃	NaCl	CaCO ₃	NaCl	CaCO ₃	
1.60	0.0079	1	0.0112	1.49	0.150	
6.18	0.0086	4	0.0140	5.69	0.160	
9.25	0.0094	8	0.0137	11.06	0.174	
11.48	0.0104	10	0.0134	15.83	0.172	
16.66	0.0106	15	0.0119	19.62	0.159	
22.04	0.0115	20	0.0106	29.89	0.123	
30.50	0.0119	25	0.0085	35.85	0.103	

Data for the solubility of calcium carbonate in aqueous solutions of mixtures of sodium chloride and sodium sulfate in contact with air and with CO₂ are given by Cameron, Bell and Robinson (1907).

Data for solubility of CaCO₃ in aqueous NaCl and other salt solutions, determined by boiling and cooling the solution, are given by Gothe (1915).

SOLUBILITY OF CALCIUM CARBONATE IN VERY DILUTE
SODIUM CHLORIDE SOLUTIONS AT 25°
(Askew, 1923)

Results are also given by Shternina and Frolova, 1952.

Molarity of NaCl	moles CaCO ₃ x 10 ⁻⁵ per liter sat. solution in:		Molarity of NaCl	moles CaCO ₃ x 10 ⁻⁵ per liter sat. solution in:	
	Ordinary distilled water	Freshly boiled water		Ordinary distilled water	Freshly boiled water
0.0	19.6	13.4	0.00250	22.2	17.9
0.00100	16.3	16.1	.00500	28.4	24.1
.00125	16.1	16.1	.00667	32.1	25.0
.00167	16.5	17.9	.0100	35.9	28.6
.00200	19.1	17.9	.0200	69.0	52.0

Ca CALCIUM

SOLUBILITY OF CaCO_3 IN NaCl SOLUTIONS AT 5° (Ehlert and Hempel, 1912)

Solvent:		Solvent:	
Gms. NaCl per 1000 gms. H_2O	Gms. CaCO_3 per 1000 cc solvent	Gms. NaCl per 1000 gms. H_2O	Gms. CaCO_3 per 1000 cc solvent
0	2.337	106.9	3.690
28	3.280	175.6	3.350
50	3.740	263.4	2.811
86	3.783	351.2(8°)	2.163

Results at 60°

CO

One liter aqueous solution containing 175.5 gms. NaCl dissolves 0.062 gm. calcite at 60° .

One liter aqueous solution containing 175.5 gms. NaCl dissolves 0.071 gm. aragonite at 60° . (Warynski and Kouropatwinska, 1916).

SOLUBILITY OF CALCITE IN SEA WATER (Wells, 1918)

In a previous paper (1915) the author showed that the solubility of calcite in water in contact with air is a function of the temperature. In the present case an excess of calcite was suspended in sea water and agitated by a current of out-door air for long intervals at different temperatures, and the dissolved carbonate determined by titration with 0.02 normal NaHSO_4 solution, using methyl orange as the indicator. The results show that there is a tendency for the colder sea water to retain more carbonate in solution than the warmer sea water... Ordinary sea water appears to contain so much carbonate that, in contact with the atmosphere at 1°C . it neither has, nor acquires an appreciable solvent action on calcite."

Data for the solubility of CaCO_3 in tropical sea water is given by Smith (1941).

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS KCl SOLUTIONS

Results at 25°

(Cameron and Robinson, 1907; Askew, 1923)

The results of Cameron and co-workers are considered by Frear and Johnston, 1929, to be of only qualitative significance since the experimental conditions were insufficiently controlled.

(Cont.)

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS KCl SOLUTIONS—Cont.

Results at 25°
(Cameron and Robinson, 1907; Askew, 1923)

(A.) In freshly boiled water moles per liter		(C. & R.) In contact with 1 atmosphere of CO ₂ Gms. per 100 Gms. Sat. Sol.		(C. & R.) In contact with air Gms. per 100 Gms. Sat. Sol.	
KCl	CaCO ₃	KCl	CaCO ₃	KCl	CaCO ₃
0.00100	0.000143	0	0.062	0	0.0013 CO
.00167	.000150	3.9	0.145	3.9	0.0078
.00250	.000170	7.23	0.150	7.23	0.0078
.00500	.000241	13.82	0.165	13.82	0.0072
.00667	.000250	18.21	0.154	18.21	0.0070
.01	.000268	26	0.126	26	0.0060
.02	.000320				

Results at 60°
(Warynaki and Kouropatwinska, 1916)

Gms. per liter		Gms. per liter	
KCl	Calcite	KCl	Aragonite
223.8	0.075	223.8	0.093

In an attempt to ascertain whether salts of potassium are fixed in the soil by their action upon calcium carbonate according to the reversible reaction $\text{CaCO}_3 + 2\text{KCl} \rightleftharpoons \text{K}_2\text{CO}_3 + \text{CaCl}_2$ Dubrisay and Francois, 1931, showed that aqueous solutions of KCl of increasing concentration, saturated with calcium carbonate in absence of CO₂, required increasing amounts of N/3 H₂SO₄ to neutralize their alkalinity.

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE

Results at 12°-18°
(Cantoni and Goguella, 1905)
(Flasks allowed to stand
98 days)
Gms. per Liter Sat. Sol.

NH ₄ Cl	CaCO ₃
53.5	0.423
100	0.609
200	0.645

Results at 25°
(Rindell, 1910)
(Constant agitation 24 hrs.)
Gms. per Liter Sat. Sol.

NH ₄ Cl	CaCO ₃
6.7	0.285
13.4	0.373
26.8	0.502
53.5	0.678

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE--Cont.

Results at 60° for Calcite and Aragonite
(Warynski and Kouropatwiska, 1916)

Gms. per Liter		Gms. per Liter	
NH ₄ Cl	Calcite	NH ₄ Cl	Aragonite
0	0.028	0	0.041
1.07	0.164	1.07	0.184
5.35	0.333	5.35	0.371
10.70	0.453	10.70	0.505
CO 26.76	0.664	26.76	0.728
53.52	0.934	53.52	1.015
160.56	1.21	160.56	1.36

SOLUBILITY OF CALCIUM CARBONATE IN SODIUM SULFATE SOLUTIONS

Results at 15°
(Ehlert and Hempel, 1912)

Gms. Na ₂ SO ₄ ·10H ₂ O per 1000 gms. H ₂ O:	105.3	Sat'd.
Gms. CaCO ₃ per 1000 cc solvent	1.406	1.920

Results at about 25°

NOTE: These results are considered unreliable by Freer and Johnston, 1929.

Solutions in contact with:

CO ₂ Free Air at 25° (Cameron, Bell and Robinson, 1907)		Ordinary Air at 24° (Cameron and Seidell, 1902)	
Gms. per 100 Gms. H ₂ O		Gms. Na ₂ SO ₄ per Liter	Gms. Total Ca per Liter Calc. as Ca(HCO ₃) ₂
Na ₂ SO ₄	CaCO ₃		
0.97	0.0151	5	0.175
1.65	0.0180	10	0.232
4.90	0.0262	20	0.277
12.69	0.0313	40	0.332
14.55	0.0322	80	0.400
19.38	0.0346	150	0.510
23.90	0.0360	250	0.725

Results at High Temperatures
(Straub, 1932)

The author used small steel bombs heated electrically in large boxes. Although analyses showed that equilibrium was reached in 6-10 hours, 90 hours was allowed for each experiment.

(Cont.)

SOLUBILITY OF CALCIUM CARBONATE IN SODIUM SULFATE SOLUTIONS—Cont.

Results at High Temperatures—Cont.

Results at: t° = 182° Millimoles per liter		t° = 207° Millimoles per liter		t° = 244° Millimoles per liter		t° = 316° Millimoles per liter	
Ca	SO ₄	Ca	SO ₄	Ca	SO ₄	Ca	SO ₄
0.25	0.0	0.14	0.0	0.11	0.0	0.08	0.0
0.27	3.85	0.17	1.18	0.08	3.17	0.07	3.0
0.32	11.85	0.29	3.58	0.11	11.5	0.02	2.65
0.46	17.8	0.25	11.85	0.14	16.4	0.02	11.60
		0.30	17.8			0.02	19.40

CO

SOLUBILITY OF CALCIUM CARBONATE IN SOLUTIONS OF
POTASSIUM AND MAGNESIUM SULFATESResults for Aqueous K₂SO₄ at 25°
(Cameron and Robinson, 1907)

In contact with air Gms. per 100 Gms. Sat. Sol.		In contact with 1 atmosphere of CO ₂ Gms. per 100 Gms. Sat. Sol.	
K ₂ SO ₄	CaCO ₃	K ₂ SO ₄	CaO
1.60	0.0104	0.69	0.69
3.15	0.0116	1.37	0.69
4.73	0.0132	1.67	0.47*
6.06	0.0148	2.18	0.30*
8.88	0.0192	2.99	0.24*
10.48	0.0188		

Results for aqueous
MgSO₄ at 14°

(Ehlert and Hempel, 1912) Gms. MgSO ₄ ·7H ₂ O per 1000 gms. H ₂ O		Gms. CaCO ₃ per 1000 cc solvent
105.5		2.177
Sat'd.		0.914

*Solid phase syngenite.

Bountine and Bykof (1935) showed that considerably more Bicarbonate exists in the system CaCO₃ + K₂SO₄ + H₂O than in the system CaCO₃ + CO₂ + H₂O because of the reaction Ca(HCO₃)₂ + K₂SO₄ ⇌ 2KHCO₃ + CaSO₄.

SOLUBILITY OF CALCIUM CARBONATE IN ALKALI
CITRATE SOLUTIONS AT 18° AND 25°

(Rindell, 1910 (25°); Schmell and Hennig, 1950 (18°))

moles citrate per liter	- Grams CaCO ₃ per liter -				
	0.0625	0.125	0.200	0.250	0.500
(NH ₄) ₃ C ₆ H ₅ O ₇	1.492	2.264	2.39 (18°)	3.980	6.687
Na ₃ C ₆ H ₅ O ₇	...	...	0.55 (18°)	...	...
K ₃ C ₆ H ₅ O ₇	...	...	0.61 (18°)	...	...

Ca CALCIUM

SOLUBILITY OF CALCIUM CARBONATE IN SOLUTIONS OF SEVERAL SALTS

In aq. NH_4NO_3

At 18°
(Berju and Kosminiko,
1904)
Gms. per Liter
Sat. Sol.

At 25°
At 25°
(Rindell, 1910)
Gms. per Liter
Sat. Sol.

CO

NH_4NO_3		CaCO_3	NH_4NO_3		CaCO_3
0		0.131	5		0.200
5		0.211	10		0.278
10		0.258	20		0.383
20		0.340	40		0.526
40		0.462			
80		0.584			

In aq. MgCl_2 at 5°

Gms. $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ per 1000 gms. H_2O	Gms. CaCO_3 per 1000 cc solvent	Gms. $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ per 1000 gms. H_2O	Gms. CaCO_3 per 1000 cc solvent
0	2.337	700	2.736
6.1	2.352	1150	2.205
50	3.404	1725	1.706
86.9	4.083	2300 (sat'd.)	1.406
350	3.301		

In aq. NaBr , NaClO_3 , NaNO_3 , and KBr at 25°
(Askew, 1923)

The data in NaCl and KCl are repeated on p. 550, 552.

Flasks of Jena glass, provided with mercury-sealed stirrers, were used. After constant stirring for several days the Ca in the solution was estimated as oxide or sulfate. The effect of traces of CO_2 is very great since ordinary distilled water gave much higher values than freshly boiled water. Thus:

Ordinary distilled water gave 19.6×10^{-5} gm. mols CaCO_3 per liter,
and Gas free " " 13.4×10^{-5} " " "

Gm. mols. $\text{CaCO}_3 \times 10^{-5}$ per liter of aqueous
sat. solution of concentration:

Salt used	M 1000	M 800	M 600	M 500	M 400	M 200	M 150	M 100	M 50
NaCl	16.1	16.1	17.9	17.9	17.9	24.1	25.0	28.6	52.0
" *	16.3	16.1	16.5	19.1	22.2	28.4	32.1	35.9	69.0
NaBr	11.6	12.5	15.2	16.1	17.1	20.5	23.4	25.0	40.9
NaClO_3	17.0	17.9	16.1	16.1	16.1	25.0	27.7	32.0	63.4
NaNO_3	16.1	16.1	17.9	17.9	19.3	28.6	30.4	34.5	67.8
KCl	14.3	..	15.0	..	17.0	24.1	25.0	26.8	32.0
KBr	15.2	..	16.1	..	..	21.4	25.0	24.1	41.7

*In ordinary distilled water, instead of freshly boiled distilled water.

Estimations of hydrolysis made by electromotive force measurements are also given.

SOLUBILITY OF CALCIUM CARBONATE IN SOLUTIONS OF SEVERAL SALTS—Cont.

In CO₂-free water containing NaCl, Na₂SO₄, NaOH and Na₂CO₃ at 100°
(Leick, 1932, 1933)

The determinations showed that 0.021 gm. CaO (= 0.0375 gm. CaCO₃) were dissolved per liter. The value varied, however, with the amount of excess of CaCO₃ present in the mixture during the period of boiling. It was also found that NaCl and Na₂SO₄ increase, and NaOH and Na₂CO₃ decrease the amount of CaCO₃ dissolved.

Greenwald (1945) showed that the solubility of Calcium Carbonate is increased by the presence of Calcium Phosphate. He presents data at constant ionic strength with varying amounts of Phosphate and varying pH. CO

SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS
OF ALBUMIN AND GLOBULIN AT 25°
(Pauli and Stenzinger, 1929)

Solvent	Gms. CaCO ₃ per 100 gms. sat. sol.
Water	0.0011
0.5% aq. Serumalbumin	0.0139
0.5% aq. Pseudoglobulin	0.0074
0.5% aq. Hemoglobulin	0.0067

Determinations of the solubility of Bone in aqueous solutions of magnesium salts (Forbes, 1931), made by digesting, with periodic shaking, finely chopped and washed, air dried beef rib bone, in pure water and in various buffer solutions containing increasing amounts of MgCl₂ and MgSO₄, showed that the amount of bone calcium in water solutions is greatly increased by magnesium salts. Increasing the calcium and phosphate concentration of the original solution decreases the dissolving action of the magnesium salts, especially at low temperatures.

THE SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SALT
SOLUTIONS AND BIOLOGICAL FLUIDS AT 38°
(Hastings, Murray and Sendroy Jr., 1927)

It is pointed out that a knowledge of the factors affecting the precipitation and solution of calcium carbonate and calcium phosphate, is necessary for the elucidation of such physiological problems as bone and tooth formation and such pathological problems as rickets and arteriosclerosis. An extensive study has, therefore, been made of the solubility of calcium carbonate, of calcium phosphate and of mixtures of the two in salt solutions and in biological fluids. The experimental data given in this first section of the paper include determinations of the solubility of CaCO₃ in aqueous NaCl and NaHCO₃ solutions and in aqueous sodium citrate solutions. Results for the solubility in serum are then given and particular attention is paid to the effect upon this solubility of the variation of such factors as time of shaking, concentration of the serum, its calcium and protein content, and the p_H + value of the medium.

Ca CALCIUM

SIMULTANEOUS SOLUBILITY OF CALCIUM CARBONATE AND CALCIUM PHOSPHATE IN AQUEOUS SALT SOLUTIONS AND BIOLOGICAL FLUIDS AT 38° (Sendroy Jr. and Hastings, 1927)

Experiments of the general type mentioned on p. 556 are reported. In the case of the results with serum, it was found that the amount of the two salts dissolved is directly proportional to the serum content of the solution. It was observed that calcium exists in serum in abnormal amounts and is bound to some substance or substances which hold it in solution in unionized form.

Data for the solubility of CaCO_3 at 19°-21° in steer serum in contact with different amounts of CO_2 are given by Irving, 1926.

The solubility product of CaCO_3 in beet juices was determined by Dedeck (1946).

SOLUBILITY OF CaCO_3 IN FURFURAL

100 gms. of Furfural Solution saturated with CaCO_3 at 25° contain 0.04 gms. CaCO_3 (Trimble, 1941).

CO CALCIUM URANYL CARBONATE $\text{Ca}_2\text{UO}_2(\text{CO}_3)_3 \cdot 10\text{H}_2\text{O}$

CO

SOLUBILITY IN WATER

(Bachelet, Cheylan, Dovia and Goulette, 1952)

The salt hydrolyzes above 60°.

t°	0°	23°	40°	55°
Gms. U per liter sol'n.	0.33	1.34	3.68	5.02
Gms. $\text{Ca}_2\text{UO}_2(\text{CO}_3)_3 \cdot 10\text{H}_2\text{O}$ per liter sol'n.	1	4	8	15

Fusion-point data have been determined for:

$\text{CaCO}_3 + \text{CaCl}_2$	(Sackur, 1911-12)
$\text{CaO} + \text{CO}_2 + \text{Na}_2\text{O} + \text{K}_2\text{O} + \text{TiO}_2 + \text{SiO}_2$	(Niggli, 1916-19)
$\text{CaCO}_3 + \text{CaO}$	(Smyth and Adams, 1923)
$\text{CaCO}_3 + \text{CaSiO}_4$	(Eitel, 1922-1923)
$\text{CaCO}_3 + \text{NaAlSiO}_4$	(" " ")
$\text{CaCO}_3 + \text{Na}_2\text{CO}_3$	(" , 1925)
$\text{CaCO}_3 + \text{Li}_2\text{CO}_3$	(Skatiks, 1928)
$\text{CaCO}_3 + \text{K}_2\text{CO}_3$	(Kroger, Illner and Graeser, 1948)

CALCIUM Camphor CARBONATE $\text{Ca}(\text{C}_{10}\text{H}_{16}\text{O} \cdot \text{CO}_2)_2$

SOLUBILITY IN WATER AND OTHER SOLVENTS (Picon, 1931)

The compound was prepared by precipitating aqueous 10 percent sodium camphor carbonate with 10 percent calcium chloride solution at about 95°. The following results for other solvents than water and alcohols were obtained with calcium camphor carbonate which had been boiled with

SOLUBILITY IN WATER AND OTHER SOLVENTS--Cont.

benzene. This treatment was found to render the compound soluble in a number of solvents in which it is insoluble before treatment with benzene.

Solvent	t°	Gms. Ca(C ₁₁ H ₁₅ O ₃) ₂ per liter sat. sol.	Solvent	t°	Gms. Ca(C ₁₁ H ₁₅ O ₃) ₂ per liter sat. sol.
Water	5.5	8.53	Chloroform	14	49.6
Methyl alcohol	5.5	1.64	Carbon		
Ethyl alcohol	5.5	2.35	tetrachloride	15	96.75
Ethyl acetate	15.0	18.85	Carbon disulfide	15	183.05
Benzene	5.5	132.0	Petroleum ether	14	5.12
			Petroleum	14	6.8

CALCIUM OXALATE CaC₂O₄

CO

SOLUBILITY IN WATER
(Solid Phase CaC₂O₄·H₂O)

t°	Gms. CaC ₂ O ₄ per liter sat. sol'n.	Author
13	0.0067	Holleman
18	0.0056	Kohlrausch and Rose, 1893
	0.0060	Scholder, Gadenne and Nieman, 1937
20	0.0066	Aumeras, 1927
	0.0073	" "
24	0.0080	Holleman
25	0.0063	Nydahl, 1951
	0.00584	McComas and Rieman, 1942
	0.0054	Kurashvili, 1939; Ruff, 1929
	0.0062	Pederson, 1939
	0.0086	Kolthoff and Sandell, 1933
	0.009	Henderson and Taylor, 1916
	0.0068	Richards, McCaffrey and Bisbee, 1901
30	0.00827	Shehyn and Pall, 1940
37	0.00711	Hammarsten, 1929
45	0.0090	Aumeras, 1927
50	0.0095	Richards, McCaffrey and Bisbee, 1901
55	0.0100	Aumeras, 1927
65	0.0120	" "
95	0.0145	Shehyn and Pall, 1940
	0.0140	Richards, McCaffrey and Bisbee, 1901

The solubility product of calcium oxalate is given by Ruff, 1929, as 1.78×10^{-9} . (0.0054 g/l).

Ca CALCIUM

SOLUBILITY OF CALCIUM OXALATE IN OXALIC ACID SOLUTIONS AT 25°
(Kurashvili, 1939)

Moles $\text{H}_2\text{C}_2\text{O}_4$ per liter	CaC_2O_4		Moles $\text{H}_2\text{C}_2\text{O}_4$ per liter	CaC_2O_4	
	gms./l	moles/l		gms./l	moles/l
0.0	0.0054	0.42×10^{-4}	0.150	0.0288	2.25×10^{-4}
0.001	0.0136	1.06 "	0.300	0.0272	2.10 "
0.010	0.0160	1.25 "	0.650	0.0160	1.25 "
0.100	0.0182	1.42 "	0.790	0.0077	0.60 "

C0 SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS OF
HYDROCHLORIC ACID AT 25°
(Henderson and Taylor, 1916)

Normality of HCl	Gms. CaC_2O_4 per Liter Sat. Sol.	Normality of HCl	Gms. CaC_2O_4 per Liter Sat. Sol.
0	0.009	0.500	2.638
0.125	0.717	0.625	3.319
0.250	1.359	0.750	3.922
0.375	2.019	1	5.210

These authors also give data showing the effect of increasing amounts of KCl and KNO_3 upon the solubility of calcium oxalate in 0.5 normal HCl at 25°, and also of the effect of increasing amounts of potassium trichloroacetic acid upon the solubility in 0.5 normal tri-chloroacetic acid, and of increasing amounts of potassium monochloroacetic acid upon the solubility of calcium oxalate in 0.5 normal monochloroacetic acid.

Determinations of the solubility of calcium oxalate in dilute HCl made by a titration method are reported by Aumeras, 1927. The author mixed measured volumes of 0.1 normal solutions of oxalic acid and of calcium chloride, and added successive amounts of normal hydrochloric acid, until the precipitate of calcium oxalate just disappeared. He gave results showing the influence of excess of oxalic acid, of calcium chloride and of increase in temperature, upon the solubility of calcium oxalate measured in this manner.

This system was also studied by Trapp, 1935. Increasing amounts of calcium chloride and oxalic acid were added to mixtures of these compounds and water, shaken together at 20°. The results are expressed in terms of volume of standard sodium hydroxide and potassium permanganate required for a given weight of the sat. solution.

SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS
OF ACETIC ACID AT 26°-27°
(Herz and Muhs, 1903)

The residues were dried at 70°. The value in water is much higher than that of other workers (p. 558).

(Cont.)

SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS
OF ACETIC ACID AT 26°-27°--Cont.

Normality of Acetic Acid	G. CH_3COOH per 100 cc. Sol.	Residue from 50.052 cc. Solution
0	0.00	0.0017
0.58	3.48	0.0048
2.89	17.34	0.0058
5.79	34.74	0.0064

SOLUBILITY OF CALCIUM OXALATE IN ACID PHOSPHATE SOLUTIONS AT 38°

CO

The solubility of Calcium Oxalate in solutions from pH 1.56 to 10.40 prepared by mixing 0.2 M H_3PO_4 with 0.2 M NaOH in varying proportions at 38° was determined by Hoover and Wijesinha, 1945. The data (reported in ml. of 0.01 N KMnO_4 used to titrate 100 ml. of saturated solution) show a minimum solubility at a pH of about 6, and the salt is much more soluble in the basic Phosphate Solutions than when excess acid is present. In other experiments, the presence of acetate and borate ions was found not to affect the solubility.

Further data on the solubility in phosphate buffer solutions is given by Hammarsten, 1929.

SOLUBILITY OF CALCIUM OXALATE IN SOLUTIONS OF BASES

One liter aq. 1.91 normal NH_3 solution dissolves 0.0297 gm. CaC_2O_4 at 25°.

One liter aq. 2.12 normal NH_3 solution dissolves 0.0385 gm. CaC_2O_4 at 25°. (Bassett, 1934).

Other data in NH_3 solutions are given by Tananaev and Pochinok, 1932.

For results in aq. NaOH, see the data of Kolthoff and Sandell (p. 565).

SOLUBILITY OF CALCIUM OXALATE IN AMMONIUM OXALATE SOLUTIONS AT 25°
(Nydahl, 1951)

Data are also given by Tananaev and Pochinok, 1932.

Moles per liter sat. sol.		Moles per liter sat. sol.	
$(\text{NH}_4)_2\text{C}_2\text{O}_4$	CaC_2O_4	$(\text{NH}_4)_2\text{C}_2\text{O}_4$	CaC_2O_4
0.0	4.9×10^{-6}	0.03	4.3×10^{-6}
0.001	5.9 "	0.1	5.3 "
0.003	4.2 "	0.3	8.8 "
0.01	3.8 "		

Ca CALCIUM

SOLUBILITY OF CALCIUM OXALATE IN SODIUM CHLORIDE SOLUTIONS

[Hammarsten, 1929 (37°); McComas and Rieman, 1942 (25°); Gerard, 1901 (at both 25° and 37°, in parentheses); Maljaroff and Gluschakoff, 1933 (18-20°)]

	Moles NaCl per liter solvent	Mg. CaC_2O_4 per liter sat. sol.		Moles NaCl per liter solvent	Mg. CaC_2O_4 per liter sat. sol.	
		25°	37°		25°	37°
CO	0.0	5.84	7.11	0.20	19.8	24.6
	.001	...	8.65	.30	22.6	...
	.005	...	10.51	.40	25.0	32.9
	.01	...	11.72	.427	(29.1)	(41.4)
	.0171	(7.5)	...	.50	27.0	...
	.02	...	13.13	.60	28.9	37.7
	.04	...	15.35	.70	30.5	...
	.0855	(18.8)	...	.80	31.8	...
	.10	15.1	20.64	.90	33.4	...
	.171	(25.5)	...	1.00	34.7	...

Results at 18-20°

Gms. NaCl per 100 gms. solvent	Gms. CaC_2O_4 per liter sat. sol.
1.25	0.0019
2.50	0.0024
5.00	0.0030
10.00	0.0036

SOLUBILITY OF CALCIUM OXALATE IN KCl, NH_4Cl AND LiCl SOLUTIONS
(18°-20°-Maljaroff and Gluschakoff, 1933; 25°-McComas and Rieman, 1942;
37°-Hammarsten, 1929; 27.5, 50, 95°-Shehyn and Pall, 1940)

In aq. KCl

Moles KCl per liter solvent	Moles CaC_2O_4 per liter sat. sol.	Moles KCl per liter solvent	Moles CaC_2O_4 per liter sat. sol.
at 25° (McC. & R.)		at 37° (H.)--Cont.	
0.64	23.0×10^{-5}	0.02	10.3×10^{-5}
		0.04	11.3 "
		0.10	15.6 "
		0.20	19.6 "
at 37° (H.)			
0.0	5.55×10^{-5}		
0.005	7.9 "		
0.01	9.7 "		

(Cont.)

SOLUBILITY OF CALCIUM OXALATE IN KCl, NH₄Cl AND LiCl SOLUTIONS--Cont.In Aq. NH₄Cl*

at 18-20° (M. & G.)

Gms. NH ₄ Cl per 100 gms. solvent	Mg CaC ₂ O ₄ per liter sat. sol.	Gms. NH ₄ Cl per liter solvent	Mg CaC ₂ O ₄ per liter sat. sol.
0.312	9.2		at 50°
0.625	16.2	3	21.62
1.25	21.6	15	41.42
2.50	29.1	40	61.14
5.00	37.3		
10.00	43.7		at 95°

Gms. NH ₄ Cl per liter solvent	Mg CaC ₂ O ₄ per liter sat. sol.	Gms. NH ₄ Cl per liter solvent	Mg CaC ₂ O ₄ per liter sat. sol.
		0	14.5
		3	34.2
		15	66.9
		40	104.7

at 27.5° (S. & P.)

3	16.40
15	28.63
40	41.22

*Data are also given by Tananaev and Pochinok, 1932.

In aq. LiCl
at 37° (H.)

Moles LiCl per liter solvent	Moles CaC ₂ O ₄ per liter sat. sol.	Moles LiCl per liter solvent	Moles CaC ₂ O ₄ per liter sat. sol.
0.0	5.55 x 10 ⁻³	0.04	12.4 x 10 ⁻³
0.005	8.1 "	0.10	15.0 "
0.01	6.9 "	0.20	19.9 "
0.02	9.9 "		

SOLUBILITY OF CALCIUM OXALATE IN AMMONIUM NITRATE AND
AMMONIUM SULFATE SOLUTIONS

Results of Maljaroff and Gluschakoff, 1933

Gms. salt per 100 gms. solvent	Mg. CaC ₂ O ₄ per liter sat. sol'n. in	
	aq. NH ₄ NO ₃	aq. (NH ₄) ₂ SO ₄
0.312	5.9	5.9
0.625	7.7	7.7
1.25	9.7	9.4
2.50	11.5	11.2
5.00	15.8	12.9
10.00	22.1	15.3

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM OXALATE IN AMMONIUM NITRATE AND AMMONIUM SULFATE SOLUTIONS--Cont.

Results of Shehyn and Pall, 1940

Mg. CaC_2O_4 per liter sat. soln.

Gms. sat. per liter solvent	$(\text{NH}_4)_2\text{SO}_4$ (30°)	$(\text{NH}_4)_2\text{SO}_4$ (50°)	$(\text{NH}_4)_2\text{SO}_4$ (95°)	NH_4NO_3 (27.5°)
3	21.5	28.85	47.5	14.66
15	42.4	56.8	...	...
25	...	...	134.0	...
CO 27.5	57.0	...	...	...
40	71.5	97.8	...	35.77
80	...	...	...	46.49
90	109.4	147.2	314.5	...

SOLUBILITY OF CALCIUM OXALATE IN VARIOUS OTHER SALT SOLUTIONS

Results of Hammarsten, 1929 at 37°

The figures in parentheses show the pH of the solutions. Results are also given for the solubility of calcium oxalate in phosphate buffer solutions and mixtures of some of the above salts.

Gm. mols. salt per liter aq. solvent	Gm. mols. $\text{CaC}_2\text{O}_4 \times 10^{-5}$ per liter sat. sol. in aq:			
	K_2SO_4	MgCl_2^*	NaH_2PO_4	$\text{Na}_2\text{HPO}_4^\dagger$
0.002	6.9(10.7)	15.4(7.0)	...	11.1
0.004	6.5(11.7)	20.7(6.5)	7.9(5.4)	14.3
0.008	...	28.5(7.0)	8.8(5.1)	135.9
0.012	...	...	...	186.5
0.016	6.8(15.4)	40.3(7.0)	8.8(5.1)	231.2
0.024	6.7(17.8)	...	...	...
0.032	6.8(19.5)	57.2(6.7)	10.6(5.0)	364.5
0.047	...	...	11.2(5.10)	...
0.098	...	...	15.9(5.0)	...

*See below for further data in MgCl_2 solutions.

†Data of Gerard (1901):

A liter of solution containing 4.8 gms. Na_2HPO_4 dissolves 15 mg. CaC_2O_4 at 15° and 33 mg. at 37°.

Results of Maljaroff and Gluschakoff, 1933 at 18-20°

An excess of precipitated, washed and air dried calcium oxalate was shaken from time to time with each salt solution, until successive titrations of the supernatant solution with standard permanganate, showed no further change.

Gms. salt per 100 gms. aq. solvent	Gms. CaC_2O_4 per liter sat. solution in aq.:	
	MgCl_2^*	MgSO_4
0.312	0.0322	0.0375
0.625	0.0556	0.0682

SOLUBILITY OF CALCIUM OXALATE IN VARIOUS OTHER SALT SOLUTIONS--Cont.

Results of Maljaroff and Gluschakoff, 1933 at 18-20°--Cont.

Gms. sat. per 100 gms. aq. solvent	Gms. CaC_2O_4 per liter sat. solution in aq.: MgCl_2^*	MgSO_4
1.25	0.1049	0.1049
2.50		0.1732
5.00		0.2812
10.00		0.4649
		0.5256

*See table above for further data on MgCl_2 solutions.

Results of Shehyn and Pall, 1940 (28, 30, 50, 90°)

Gms. Na_2SO_4 per liter solvent	Mg. CaC_2O_4 per Liter Sat. Soln.				
	25°	28°	30°	50°	95°
0.0	5.84	...	8.27	...	14.5
3	...	17.18	..	24.97	39.9
15	...	34.08	..	49.75	83.5
30.25	44.8	...	..	...	...
40	...	55.19	..	84.30	144.0

A solution containing 22.7 gms. ammonium formate per liter will dissolve 28.6 gms. CaC_2O_4 at 25°. McComas and Rieman, 1942.

THE SYSTEM CALCIUM OXALATE - URANIUM OXALATE - WATER
(Colani, 1934)

Weighed amounts of calcium oxalate and uranyl oxalate were added to a given volume of water and the mixtures agitated until attainment of equilibrium. The supernatant solutions were analyzed gravimetrically. This method is not sufficiently accurate for the determinations of the solubility of the alkaline earth oxalates, but due to the considerable increase in the solubility of these oxalates, by very small quantities of uranyl oxalate, it yields satisfactorily concordant results.

Results at 15°			Results at 50°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{UO}_2\text{C}_2\text{O}_4$	CaC_2O_4		$\text{UO}_2\text{C}_2\text{O}_4$	CaC_2O_4	
0.088	0.075	$\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$	0.239	0.017	$\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$
0.137	0.079	"	0.924	0.037	"
0.260	0.011	"	1.04	0.038	"
0.469	0.012	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	1.07	0.044	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
0.470	0.000	"	0.996	0.022	"
			1.00	0.0	"

Ca CALCIUM

SOLUBILITY OF CALCIUM OXALATE IN SOLUTIONS OF ELECTROLYTES AT 25° (Kolthoff and Sandell, 1933)

The authors found the solubility of pure $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ to vary with the amount of excess solid which was present at equilibrium. The 'normal' solubility was measured (with a very slight excess of solid), and the amount of each ion in solutions containing an excess of solid was found to depend on the amount of ion exchange on the crystal surfaces.

CO	Electrolyte	Concentration	"Normal" solubility mmol. per liter		Solubility with 12-15 gms. $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ per 250 cc excess: mmol. per liter	
			Ca ⁺⁺ C ₂ O ₄ ⁼		Ca ⁺⁺ C ₂ O ₄ ⁼	
			Ca ⁺⁺	C ₂ O ₄ ⁼	Ca ⁺⁺	C ₂ O ₄ ⁼
	H ₂ O	...	0.067	0.067	0.067	0.067
	(NH ₄) ₂ SO ₄	0.01	.112	.115	.31	.05
	NH ₄ IO ₃	.01	.090	.090	.13	.058
	NaOH	.01	.126	.126	.30	.052
	BaCl ₂	.001	.078	.078	.03	.21

SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS OF UREA AT 25° (Pederson, 1939)

Gm. Mols. per liter sat. sol.			
CO(NH ₂) ₂	CaC ₂ O ₄ (obs.)	CaC ₂ O ₄ (calc.)*	Solid Phase
0.0	4.84 x 10 ⁻⁵	4.84 x 10 ⁻⁵	CaC ₂ O ₄ ·H ₂ O
0.25	4.85 "	5.06 "	"
0.50	4.87 "	5.27 "	"
0.75	4.90 "	5.48 "	"
1.00	5.02	5.79	"
2.00	5.23	6.69	"

*The calc. values were obtained by applying a correction to the observed values for 1.66×10^{-5} mol. Ca per mol. of urea estimated to be present in the sample of urea used for the determinations.

One liter 45% ethyl alcohol dissolves 0.000525 gm. calcium oxalate, temp. not stated. (Guerin, 1912).

CI CALCIUM CHLORIDE CaCl₂

THE SYSTEM CALCIUM CHLORIDE - WATER

(Roozeboom, 1889; Bassett, Barton, Foster and Paternan, 1933;
Druzhinin and Shepelev, 1950; Yanatieva, 1946;
Klein and Svanberg, 1920; Rodebush, 1918)

The various data are in good agreement. The γ-tetrahydrate was originally designated "β" by Roozeboom, who found only two of the three modifications. Information on the crystalline characteristics of the three tetrahydrates is given by Bassett, Gordon and Henshall, 1937.

THE SYSTEM CALCIUM CHLORIDE - WATER--Cont.

Many of the values below are averages read from a plot of the different results. Many solubility values at single temperatures are found in the various tables which follow.

A review of the solubility of CaCl_2 in steam up to 180 atm. is given by Styrikovich, Khaibullin and Tskhvirashvili, 1955.

Gms. CaCl_2 per 100 gms. sat. solution in contact with:

t°	Ice	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\alpha$	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\beta$	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\gamma$	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	$\text{CaCl}_2 \cdot \text{H}_2\text{O}$
-49.8	30.22(8)	30.22(8)	...	...	...	...	...
-40	28.3	32.1	...	...	...	...	...
-30	25.7	33.4	...	...	...	...	...
-20	21.3	34.7	...	...	...	...	...
-10	14.4	36.0	...	...	...	...	...
0	0.0	37.3	...	...	...	...	...
+10	...	39.3	...	...	...	...	...
15	...	41.2	46.0 ^a	49.0 ^b	...	...	...
20	...	42.7	47.5*	50.0*	51.1*	...	...
25	...	45.3	48.7*	51.2*	52.1*	...	...
27.5	...	47.2	49.3*	51.8*	52.7*	...	...
29.0	...	48.5	49.7*	52.1*	53.0(1)	...	...
29.5	...	49.1	49.8*	52.3(2)	53.2	...	...
30.1	...	50.0(3)	50.0(3)	52.5	53.5	...	...
32.5	50.7	53.1	54.0	...	...
35.0	51.5	53.9	54.8	...	...
37.5	52.4	54.7	55.7	...	...
38.5	52.7	55.1	56.0(4)	56.0(4)	...
40.0	53.4	55.9	...	56.2	...
41.0	53.8	56.3(5) ^d	...	56.3(5)	...
45.1	56.6(6) ^c	...	...	56.6(6)	...
60	57.8	...
70	58.6	...
80	59.5	...
90	60.6	...
100	61.4	...
120	63.4	...
140	65.6	...
160	69.0	...
170	71.8	...
175.5	74.8(7)	74.8(7)
180	75.0
200	75.7
235	76.8
260	77.6

Solid Phases:

- | | |
|---|---|
| (1) $\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}\gamma$ | (5) $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\beta + \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ |
| (2) $\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}\beta$ | (6) $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\alpha + \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ |
| (3) $\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}\alpha$ | (7) $\text{CaCl}_2 \cdot 2\text{H}_2\text{O} + \text{CaCl}_2 \cdot \text{H}_2\text{O}$ |
| (4) $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}\gamma + \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ | (8) $\text{Ice} + \text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ |

*metastable

^cDruzhinin and Shepelev found 55.9%

at 14°

d " " " " 55.8%

at 15.9°

Ca CALCIUM

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 0°
(Engel, 1887)

Gms. per 100 cc. Sat. Sol.		d ₀ of Sat. Sol.	Gms. per 100 cc. Sat. Sol.		d ₀ of Sat. Sol.
CaCl ₂	HCl		CaCl ₂	HCl	
51.45	0	1.367	29.84	15.84	1.283
46.45	3.32	1.344	20.12	23.15	1.250
42.80	5.83	1.326	11.29	34.62	1.238
Cl 36.77	10.66	1.310			

Results at 25°
(Millikan, 1918)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	HCl		CaCl ₂	HCl	
44.77	0.0	CaCl ₂ ·6H ₂ O	36.66	10.78	CaCl ₂ ·4H ₂ O
43.59	1.92	"	34.43	12.75	"
43.71	2.96	"	34.36	12.94	"
44.50	3.33	" + CaCl ₂ ·4H ₂ O	27.94	20.48	"
43.10	5.03	CaCl ₂ ·4H ₂ O	28.45	21.40	" + CaCl ₂ ·2H ₂ O
38.49	9.17	"	27.81	21.83	CaCl ₂ ·2H ₂ O

EQUILIBRIUM IN THE SYSTEM CALCIUM OXIDE, HYDROCHLORIC ACID AND WATER AT 25° (Millikan, 1918)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaO	HCl		CaO	HCl	
14.05	40.10	CaCl ₂ ·2H ₂ O	19.56	25.37	1.1.2
14.43	40.07	" + CaCl ₂ ·4H ₂ O	17.53	22.58	"
14.11	38.84	CaCl ₂ ·4H ₂ O	17.15	22.00	" + 1.3.16
17.36	35.52	"	16.73	21.47	1.3.16
17.39	35.38	"	15.10	19.41	"
18.52	34.87	"	14.50	18.64	"
19.44	34.46	"	12.44	15.99	"
21.77	33.35	"	12.17	15.64	"
22.48	32.57	" + CaCl ₂ ·6H ₂ O	10.77	13.81	"
22.08	31.68	CaCl ₂ ·6H ₂ O	9.28	11.88	" + Ca(OH) ₂
22.02	30.57	"	8.83	11.30	Ca(OH) ₂
22.62	29.42	"	7.79	9.95	"
22.56	29.31	" + 1.1.2	6.66	8.50	"
22.41	29.11	1.1.2	5.17	6.57	"
30.92	27.15	"	2.64	3.30	"

1.3.16 = CaCl₂·3CaO·16H₂O; 1.1.2 = CaCl₂·CaO·2H₂O

A 1.1.5 = CaCl₂·CaO·5H₂O (or 4H₂O) compound was also found.

THE SYSTEM CALCIUM CHLORIDE - CALCIUM OXIDE - WATER

The various results are in reasonable agreement. The compounds $\text{CaCl}_2 \cdot \text{CaO} \cdot x\text{H}_2\text{O}$ and $\text{CaCl}_2 \cdot 3\text{CaO} \cdot y\text{H}_2\text{O}$ have been found by all investigators, but there is some dispute over the exact degrees of hydration at each temperature. Makerov and Vol'nov list the following invariant points:

[Ratios are $\text{CaCl}_2 : \text{Ca}(\text{OH})_2 : \text{H}_2\text{O}$]

t°	Gms. per 100 gms. sat. sol.		Solid Phases	Author [unmarked lines are Makerov and Vol'nov]
	CaCl_2	$\text{Ca}(\text{OH})_2$		
-0.116	...	0.13	Ice + $\text{Ca}(\text{OH})_2$	Bassett
0.0	6.8	0.282	$\text{Ca}(\text{OH})_2$ + 1:3:13	O'Connor
3.6	...	...	1:3:13 + 1:1:1 + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	Millikan
5.0	7.57	0.15	$\text{Ca}(\text{OH})_2$ + 1:3:12	
5.0	36.58	0.19	1:3:12 + 1:1:1	
5.0	37.90	0.09	1:1:1 + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	
10.0	10.26	0.15	$\text{Ca}(\text{OH})_2$ + 1:3:12	
10.0	36.09	0.23	1:3:12 + 1:1:1	
10.0	35.94	0.20	1:3:12 + 1:1:1	Millikan
10.0	39.00	0.08	1:1:1 + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	
25.0	18.15	0.195	$\text{Ca}(\text{OH})_2$ + 1:3:13	Schreinemakers
25.0	33.21	0.323	1:3:13 + 1:1:1	Schreinemakers
25.0	44.51	0.029	1:1:1 + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	Schreinemakers
29.0	53.0	...	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ + $\gamma\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$	Bassett
29.5	52.3	...	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ + $\alpha\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$	Bassett
30.0	20.63	0.23	$\text{Ca}(\text{OH})_2$ + 1:3:12	
20.0	32.90	0.43	1:3:12 + 1:1:1	
30.0	46.60	0.06	1:1:1 + $\alpha\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$	
30.2	50.1	...	$\alpha\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$ + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	Bassett
38.5	56.0	...	$\gamma\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$ + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	Bassett
38.9	...	...	1:1:13 + 1:1:1	Millikan
40.0	31.93	0.804	$\text{Ca}(\text{OH})_2$ + 1:1:1	Millikan
40.0	32.00	0.74	$\text{Ca}(\text{OH})_2$ + 1:1:1	
40.0	49.44	0.06	1:1:1 + $\alpha\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$	
41.0	53.0	...	$\beta\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$ + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	Bassett
45.0	31.95	0.837	$\text{Ca}(\text{OH})_2$ + 1:1:1	Millikan
45	31.28	0.76	$\text{Ca}(\text{OH})_2$ + 1:1:1	
45	53.48	0.08	1:1:1 + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	
45.1	56.6	...	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$ + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	Bassett
50	31.64	0.74	$\text{Ca}(\text{OH})_2$ + 1:1:1	
50	53.81	0.09	1:1:1 + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	
55	31.76	0.76	$\text{Ca}(\text{OH})_2$ + 1:1:1	
55	54.92	0.08	1:1:1 + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	
75	30.58	0.72	$\text{Ca}(\text{OH})_2$ + 1:1:1	
75	56.98	0.12	1:1:1 + $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	

Cl

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - CALCIUM OXIDE - WATER—Cont.

Data of O'Connor, 1927 at 0°

dg of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	dg of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CaO	CaCl ₂			CaO	CaCl ₂	
1.370	0.0	37.6	CaCl ₂ ·6H ₂ O	1.133	0.164	15.2	1.3.16
1.338	0.190	34.9	1.3.16	1.111	0.172	12.5	"
1.280	0.152	29.7	"	1.089	0.186	10.2	"
1.265	0.138	28.0	"	1.067	0.212	7.6	"
1.240	0.142	25.6	"	1.056	0.216	6.8	" + Ca(OH) ₂
1.213	0.145	22.8	"	1.048	0.226	5.5	Ca(OH) ₂
1.186	0.148	20.0	"	1.025	0.214	2.7	"
1.155	0.152	17.4	"				

1.3.16 = CaCl₂·3CaO·16H₂O

Data of Millikan, 1917 from 10° to 58°

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CaO	CaCl ₂			CaO	CaCl ₂		
<u>t° = 10°</u>				<u>t° = 25°—Cont.</u>			
0.130	0		Ca(OH) ₂	0.022	44.51		1.1.2 +
0.102	15.46		" + 1.3.16				CaCl ₂ ·6H ₂ O
0.110	26.30		1.3.16	0.036	44.46		"
0.115	32.38		"	0.0	44.77		CaCl ₂ ·6H ₂ O
0.140	34.60		"				
0.151	35.44		" + 1.1.2	<u>t° = 40°</u>			
0.106	38.23		1.1.2	0.104	0.0		Ca(OH) ₂
0.126	38.45		"	0.455	29.38		"
0.0	39.4		CaCl ₂ ·6H ₂ O	0.609	31.93		" + 1.1.2
				0.571	31.90		" + "
				0.580	31.86		" + "
				0.055	49.97		1.1.2 +
<u>t° = 25°</u>							CaCl ₂ ·4H ₂ O
0.101	5.02		Ca(OH) ₂	0.0	51.18		CaCl ₂ ·4H ₂ O
0.115	10.00		"				
0.128	12.94		"	<u>t° = 45°</u>			
0.140	15.14		"	0.100	0.0		Ca(OH) ₂
0.145	17.20		"	0.621	31.72		" + 1.1.2
0.148	18.15		" + 1.3.16	0.634	31.95		"
0.147	21.02		1.3.16	0.442	35.87		1.1.2
0.146	23.80		"	0.069	38.12		"
0.147	24.33		"	0.074	43.31		"
0.170	28.37		"	0.047	52.10		"
0.180	29.54		"	0.121	59.96		" + CaCl ₂ ·2H ₂ O
0.225	32.67		"	0.0	57.19		CaCl ₂ ·2H ₂ O
0.245	33.21		" + 1.1.2				
0.173	34.36		1.1.2	<u>t° = 50°</u>			
0.060	38.61		"	0.096	0.0		Ca(OH) ₂
0.048	41.32		"	0.112	4.08		"
0.030	44.30		"				

(Cont.)

THE SYSTEM CALCIUM CHLORIDE - CALCIUM OXIDE - WATER--Cont.

Data of Millikan, 1917 from 10° to 58°--Cont.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaO	CaCl ₂		CaO	CaCl ₂	
t° = 50°—Cont.					
0.142	15.02	Ca(OH) ₂	0.051	45.57	1.1.2
0.538	29.41	"	0.046	46.42	"
0.436	29.57	"	0.034	47.19	"
0.362	29.66	" + 1.1.5	0.046	48.75	"
0.517	29.60	1.1.5	0.058	54.05	" + CaCl ₂ ·2H ₂ O
0.470	31.70	"	0.0	56.95	CaCl ₂ ·2H ₂ O
0.106	35.20	"			
0.113	36.95	" + 1.1.2	t° = 58°		
0.146	36.82	" "	0.434	31.80	Ca(OH) ₂ + 1.1.5
0.124	36.93	1.1.2	...	31.73	" "
0.069	39.43	"	0.320	32.86	1.1.5 + 1.1.2

Data of Schreinemaker at 25°

Gms. per 100 gms. sat. sol.

Ca(OH) ₂	CaCl ₂	Solid Phase
0.195	18.15	1:3:13 + Ca(OH) ₂
0.323	33.21	1:3:13 + 1:1:1
0.029	44.51	CaCl ₂ + 1:1:1

Data of Makarov and Vol'nov, 1954 from 5° to 75°

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Ca(OH) ₂	CaCl ₂	Solid Phase	Ca(OH) ₂	CaCl ₂	Solid Phase
Results at 5°			Results at 10°--Cont.		
0.18	0.0	Ca(OH) ₂	0.14	12.12	1:3:12
0.15	6.53	" + 1:3:12	0.12	18.27	"
0.15	7.57	1:3:12	0.12	25.04	"
0.13	11.06	"	0.15	30.90	"
0.11	13.62	"	0.23	36.09	" + 1:1:1
0.10	19.25	"	0.16	36.58	1:1:1
0.11	29.03	"	0.10	37.90	"
0.16	34.75	"	0.08	39.00	" + Ca.6
0.19	36.58	" + 1:1:1	0.0	39.4	Ca.6
0.10	37.04	1:1:1			
0.09	37.90	" + Ca.6	Results at 30°		
0.0	38.29	Ca.6	0.15	0.0	Ca(OH) ₂
Results at 10°			0.16	12.80	"
0.18	0.0	Ca(OH) ₂	0.21	19.61	"
0.14	7.33	"	0.23	20.63	" + 1:3:12
0.14	8.87	"	0.24	23.50	1:3:12
0.15	10.26	" + 1:3:12	0.26	26.58	"
			0.37	32.05	"

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - CALCIUM OXIDE - WATER--Cont.

Data of Makarov and Vol'nov, 1954 from 5° to 75°--Cont.

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(OH) ₂	CaCl ₂		Ca(OH) ₂	CaCl ₂	
Cl	Results at 30°--Cont.			Results at 50°--Cont.		
	0.39	32.76	1:3:12	0.23	19.64	Ca(OH) ₂
	0.43	32.90	" + 1:1:1	0.32	24.31	"
	0.22	33.85	1:1:1	0.62	30.75	" + 1:1:1
	0.15	35.96	"	0.74	31.64	" + "
	0.08	38.74	"	0.72	31.78	1:1:1
	0.07	41.88	"	0.60	32.40	"
	0.06	46.60	" + Ca.4 α	0.44	33.20	"
	0.0	49.25	Ca.4 α	0.16	36.32	"
				0.10	39.13	"
				0.09	40.42	"
				0.08	49.61	"
				0.09	53.81	" + Ca.2
				0.0	56.90	Ca.2
	Results at 40°			Results at 55°		
	0.44	0.0	Ca(OH) ₂	0.12	0.0	Ca(OH) ₂
	0.18	13.02	"	0.13	6.75	"
	0.23	19.44	"	0.18	13.35	"
	0.37	26.08	"	0.25	19.25	"
	0.58	30.00	"	0.55	28.10	"
	0.67	31.00	"	0.67	30.09	"
	0.74	32.00	" + 1:1:1	0.76	31.76	" + 1:1:1
	0.56	32.38	1:1:1	0.53	32.23	1:1:1
	0.21	34.47	"	0.37	33.27	"
	0.10	38.72	"	0.20	35.13	"
	0.05	44.29	"	0.12	36.77	"
	0.06	48.25	"	0.07	43.34	"
	0.06	49.44	" + Ca.4 α	0.07	45.48	"
	0.06	49.32	" + "	0.07	49.75	"
	0.0	52.95	Ca.4 α	0.06	52.65	"
				0.08	54.92	" + Ca.2
				0.0	57.27	Ca.2
	Results at 45°			Results at 75°		
	0.12	0.0	Ca(OH) ₂	0.10	0.0	Ca(OH) ₂
	0.13	5.45	"	0.12	6.30	"
	0.27	21.55	"	0.30	19.33	"
	0.41	28.15	"	0.55	26.03	"
	0.71	31.18	"	0.72	30.58	" + 1:1:1
	0.76	31.28	" + 1:1:1	0.30	32.99	1:1:1
	0.32	32.24	1:1:1	0.10	46.45	"
	0.13	36.05	"	0.12	56.98	" + Ca.2
	0.09	39.59	"	0.0	58.85	Ca.2
	0.06	43.69	"			
	0.07	50.63	"			
	0.08	53.48	" + Ca.2			
	0.0	56.5	Ca.2			
	Results at 50°					
	0.12	0.0	Ca(OH) ₂			
	0.20	16.89	"			

Ca.6 = CaCl₂·6H₂O Ca.4α = α-CaCl₂·4H₂O Ca.2 = CaCl₂·2H₂O
 1:1:1 = CaCl₂·Ca(OH)₂·H₂O 1:3:12 = CaCl₂·3Ca(OH)₂·12H₂O

SOLUBILITY OF CALCIUM CHLORIDE IN MIXTURES OF AMMONIA AND WATER AT 0°
(Guyer, Bieler and Schmid, 1934)

The determinations were made in a steel tube provided with a cap and valve. The results are presented only in the form of a curve from which the following approx. values were read.

Percent H ₂ O in NH ₃ + H ₂ O mixtures	0	10	15	20	25	27	28	29	30
Gms. CaCl ₂ per 100 cc sat. sol.	0	0.1	0.25	0.5	0.7	1.0	2.0	4.0	10+

THE SYSTEM CALCIUM CHLORIDE - CALCIUM HYPOCHLORITE - WATER AT 0° C1
(O'Connor, 1927)

dg of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(ClO) ₂	CaCl ₂	
1.370	0.0	37.6	CaCl ₂ ·6H ₂ O
1.382	1.6	36.9	"
1.388	2.6	36.4	" + Ca(ClO) ₂ ·3H ₂ O
1.366	2.9	34.0	Ca(ClO) ₂ ·3H ₂ O
1.333	4.2	30.7	"
1.322	4.5	28.5	"
1.285	7.4	22.2	"
1.270	8.8	19.4	"
1.255	11.0	15.4	"
1.238	14.0	10.8	"
1.234	16.1	8.4	"
1.228	18.6	5.3	"
1.220	19.6	3.1	"
1.213	21.8	0.0	"

Equilibrium diagrams for the quaternary system CaCl₂ - CaOCl₂ - Ca(OH)₂ - H₂O at 10°, 20°, 30° and 40° are given by Ourisson, 1939.

THE SYSTEM CALCIUM CHLORIDE - CALCIUM CHLORATE - WATER

Results at 20°
(Mazetti, 1929)

Gms. per 100 Gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ca(ClO ₃) ₂	CaCl ₂		Ca(ClO ₃) ₂	CaCl ₂	
0.0	42.7	CaCl ₂ ·6H ₂ O	33.47	28.29	CaCl ₂ ·4H ₂ O + Ca(ClO ₃) ₂ ·2H ₂ O
6.74	39.49	"			
10.56	37.35	"	42.85	19.67	Ca(ClO ₃) ₂ ·2H ₂ O
15.13	35.83	"	49.61	12.83	"
22.88	33.84	" + CaCl ₂ ·4H ₂ O	53.57	10.34	"
29.23	31.46	CaCl ₂ ·4H ₂ O	58.74	7.16	"
			66.16	0.0	"

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - CALCIUM CHLORATE - WATER--Cont.

Results at 25°
(Ehret, 1932)

d ₂₅ sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₂₅ Sat. Sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(ClO ₃) ₂	CaCl ₂			Ca(ClO ₃) ₂	CaCl ₂	
1.453	0.0	44.92	CaCl ₂ ·6H ₂ O	1.641	22.14	35.39	CaCl ₂ ·4H ₂ O
1.490	2.36	43.26	"	1.659	25.20	34.69	"
1.480	3.85	44.06	"	1.718	30.11	31.51	"
1.544	8.85	42.60	" + CaCl ₂ ·4H ₂ O	1.725	32.01	31.49	"
1.570	10.70	41.22	CaCl ₂ ·4H ₂ O	1.744	33.36	30.65	" + Ca(ClO ₃) ₂ ·2H ₂ O
1.565	12.12	41.70	"	1.735	33.01	30.43	Ca(ClO ₃) ₂ ·2H ₂ O
1.578	12.29	40.15	"	1.733	34.71	29.21	"
1.580	13.41	40.53	"	1.730	36.02	28.15	"
1.603	16.55	38.82	"	1.731	44.59	19.19	"
1.614	16.91	37.92	"	1.751	53.45	10.31	"
1.607	17.69	38.17	"	1.767	58.65	5.86	"
1.618	19.65	37.75	"	1.781	66.05	0.00	"
1.625	21.52	36.91	"				

Results at 55°

(Makarov and Vol'nov, 1951)

Results at 75°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ca(ClO ₃) ₂	CaCl ₂		Ca(ClO ₃) ₂	CaCl ₂	
0.0	57.27	CaCl ₂ ·2H ₂ O	0.0	58.85	CaCl ₂ ·2H ₂ O
10.06	40.44	"	7.79	53.49	"
37.92	33.16	"	16.89	47.37	"
41.74	29.69	" + Ca(ClO ₃) ₂	19.37	45.63	"
45.98	26.29	Ca(ClO ₃) ₂	23.23	42.51	"
49.04	23.87	"	27.27	40.51	"
51.78	21.04	" + Ca(ClO ₃) ₂ ·2H ₂ O	41.94	34.03	" + Ca(ClO ₃) ₂
56.01	15.59	Ca(ClO ₃) ₂ ·2H ₂ O	44.22	30.98	Ca(ClO ₃) ₂
56.23	14.28	"	50.53	24.00	"
71.75	0.0	"	70.09	5.72	"
			74.55	2.37	"
			77.83	0.0	"

Results at Various Temperatures

t°	Gms. per 100 gms. sat. sol.		Solid Phase	Author
	Ca(ClO ₃) ₂	CaCl ₂		
45	44.2	28.8	Ca(ClO ₃) ₂ ·2H ₂ O + CaCl ₂ ·2H ₂ O	(Osaka, 1930)
45	1.5	55.5	Ca(ClO ₃) ₂ ·2H ₂ O + α-CaCl ₂ ·4H ₂ O	(")
25	34.21	30.56	"	(Ehret, 1932)
25	34.20	31.20	"	(Egorov, 1935)
25	8.70	42.82	α-CaCl ₂ ·4H ₂ O + CaCl ₂ ·6H ₂ O	(Ehret, 1932)
25	11.50	42.00	"	(Egorov, 1935)
20	33.47	28.29	Ca(ClO ₃) ₂ ·2H ₂ O + α-CaCl ₂ ·4H ₂ O	(Mazzetti, 1929)

THE SYSTEM CALCIUM CHLORIDE - CALCIUM CHLORATE - WATER--Cont.

Results at Various Temperatures--Cont.

t°	Gms. per 100 gms. sat. sol.		Solid Phase	Author
	Ca(ClO ₃) ₂	CaCl ₂		
20	22.88	33.84	α -CaCl ₂ ·4H ₂ O + CaCl ₂ ·6H ₂ O	(Mazzetti, 1929)
15	33.4	28.2	Ca(ClO ₃) ₂ ·2H ₂ O + CaCl ₂ ·6H ₂ O	(Osaka, 1930)
0	42.42	16.90	" "	(Easlavskii, 1935)
-56	17.5	20.5	" " + ice	(Egorov, 1935)

Cl

THE SYSTEM CALCIUM CHLORIDE - CALCIUM NITRATE - WATER

Results-at 25°
(Ehret, 1932)

d ₂₅ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₂₅ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(NO ₃) ₂	CaCl ₂			Ca(NO ₃) ₂	CaCl ₂	
1.453	0.0	44.92	CaCl ₂ ·6H ₂ O	1.692	41.92	21.75	1.1.4
1.474	2.95	44.75	"	1.700	43.02	21.10	"
1.524	5.43	44.14	"	1.733	49.28	16.92	"
1.523	6.74	44.24	"	1.749	52.21	16.20	" + Ca(NO ₃) ₂ ·4H ₂ O
1.541	7.60	44.98	" + CaCl ₂ ·4H ₂ O	1.790	50.86	15.75	Ca(NO ₃) ₂ ·4H ₂ O
1.556	9.03	43.78	CaCl ₂ ·4H ₂ O	1.713	41.30	14.45	"
1.619	16.86	40.35	"	1.696	48.01	15.06	"
1.630	18.07	39.75	"	1.655	46.94	14.57	"
1.630	20.55	37.73	" + 1.1.4	1.625	46.45	12.91	"
1.630	20.94	37.36	1.1.4	1.616	46.17	12.02	"
1.624	21.80	36.80	"	1.595	48.72	9.19	"
1.623	22.29	37.04	"	1.590	48.93	8.24	"
1.651	31.63	29.01	"	1.588	48.88	7.78	"
1.660	34.20	27.57	"	1.581	55.03	2.26	"
				1.579	58.35	0.0	"

1.1.4 = CaCl₂·Ca(NO₃)₂·4H₂OResults at 30°
(Barbaudy, 1923)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	Ca(NO ₃) ₂		CaCl ₂	Ca(NO ₃) ₂	
45.0	10.81	CaCl ₂ ·4H ₂ O	10.7	54.4	Ca(NO ₃) ₂ ·4H ₂ O
44.7	11.45	"	11.05	53.4	"
42.35	17.03	"	7.27	52.9	"
7.57	65.26	Ca(NO ₃) ₂ ·4H ₂ O	4.6	55.0	"

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - COBALT CHLORIDE - WATER
(Bassett, Gordon and Henshall, 1937)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	CaCl ₂		CoCl ₂	CaCl ₂	
Cl	Results at 0°			Results at 25°		
	0.0	37.00	CaCl ₂ ·6H ₂ O	11.43	38.54	CoCl ₂ ·2H ₂ O
	1.64	36.25	"	13.64	34.90	"
	2.36	35.82	"	13.51	34.83	" + CoCl ₂ ·6H ₂ O
	2.85	35.48	" + CoCl ₂ ·6H ₂ O	12.52	33.46	CoCl ₂ ·6H ₂ O
	2.82	36.77	CoCl ₂ ·6H ₂ O	11.39	29.92	"
	7.22	26.42	"	12.44	26.10	"
	29.50	0.0	"	18.50	18.66	"
				23.66	12.61	"
				26.88	9.08	"
	Results at 25°†			Results at 50°		
	0.0	52.13*	CaCl ₂ ·4H ₂ Oγ	0.0	56.70	CaCl ₂ ·2H ₂ O
	6.92	47.24*	"	6.75	51.43	"
	0.0	51.30*	CaCl ₂ ·4H ₂ Oβ	11.55	47.74	"
	7.56	46.27*	"	12.79	46.63	" + CoCl ₂ ·2H ₂ O
	0.0	48.85*	CaCl ₂ ·4H ₂ Oα	13.72	42.85	CoCl ₂ ·2H ₂ O
	2.14	46.91*	"	23.24	25.98	"
	4.92	45.27*	"	27.67	20.87	"
	8.76	42.91*	"	35.41	11.88	"
	9.51	42.53*	" + CoCl ₂ ·2H ₂ O	40.22	7.87	"
	0.0	45.05	CaCl ₂ ·6H ₂ O	41.92	6.31	" + CoCl ₂ ·6H ₂ O
	2.77	43.37	"	43.50	5.34	CoCl ₂ ·6H ₂ O
	8.34	41.13	"	46.00	0.0	"
	10.36	40.63	" + CoCl ₂ ·2H ₂ O			
	9.75	41.99*	CoCl ₂ ·2H ₂ O			

* = metastable equilibrium

†Additional data on this system at 25° are given by Benrath, 1927.

Results for the system Calcium Chloride - Cadmium Chloride - Water at 25° are given on p. 723.

THE SYSTEM CALCIUM CHLORIDE - INDIUM CHLORIDE - WATER AT ROOM TEMPERATURE
(Ensslin, Ziemeck, and Schaeppdryver, 1947)

	Gms. per 100 ml. Sat. Sol.		Solid Phase	Gms. per 100 ml. Sat. Sol.		Solid Phase
	InCl ₃	CaCl ₂		InCl ₃	CaCl ₂	
	143.9	8.4	InCl ₃ ·4H ₂ O	93.4	30.6	CaCl ₂ ·InCl ₃ ·8H ₂ O
	135.3	10.8	CaCl ₂ ·2InCl ₃ ·12H ₂ O	64.3	45.8	"
	127.6	13.6	3CaCl ₂ ·4InCl ₃ ·30H ₂ O	54.3	54.5	"
				12.4	60.1	"
				36.2	67.3	"

THE SYSTEM CALCIUM CHLORIDE - MERCURIC CHLORIDE - WATER AT 25°
(Bassett, Barton, Foster and Pateman, 1933)

This system is of unusual complexity due to the occurrence at 25° of two double salts and three different hydrates of calcium chloride of which one, the tetrahydrate, occurs in no less than three distinct forms. Four of the curves are entirely metastable.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Solid Phase	
HgCl ₂	CaCl ₂		HgCl ₂	CaCl ₂		HgCl ₂	CaCl ₂			
0.0	42.05	6	51.20	24.46*	4α	49.16	26.17*	2		Cl
17.04	38.36	6	0.0	51.30*	4β	50.30	25.50*	2		
20.08	37.04	6	24.71	37.73*	4β + 6	50.76	25.38*	2 + C		
23.73	35.95	6	32.73	33.65*	4β	50.81	25.30*	B + C		
24.00	36.00	6 + 4α	46.03	27.15*	4β	50.76	25.24*	B + 2		
24.71	37.73*	6 + 4β	45.82	27.90*	4β + 2	52.15	23.53	B + 4α		
23.00	39.30*	6 + 4γ	0.0	52.13*	4γ	54.87	20.40	B		
0.0	48.85	4α	24.25	38.50*	4γ + 6	55.58	17.81	B		
30.70	32.72	4α	25.10	37.99*	4γ	55.68	14.70	B		
39.97	29.01	4α	37.14	32.36*	4γ	56.31	12.60	B		
41.62	27.99	4α	39.24	31.61*	4γ + 2	56.71	11.35	B + HgCl ₂		
47.19	25.65	4α	0.0	55.00*	2	52.66	10.53	HgCl ₂		
50.08	24.71	4α	45.82	27.90*	4β + 2	38.50	7.25	"		
52.21	23.62	4α	46.06	27.70*	2	6.90	0.0			
51.97	23.96*	4α + B	47.01	27.22*	2					

* = metastable equilibrium

6 = CaCl₂·6H₂O; 2 = CaCl₂·2H₂O; 4α = CaCl₂·4H₂Oα; 4β = CaCl₂·4H₂Oβ;
4γ = CaCl₂·4H₂Oγ; B = [Ca(H₂O)₆][(HgCl₂)₆Cl₂]; C = [Ca(H₂O)₄][HgCl₄].

THE SYSTEM CALCIUM CHLORIDE - POTASSIUM CHLORIDE - WATER

Results at 0°

(Igelsrud and Thompson, 1936)

Gms. per 100 gms. sat. sol.		Solid Phase
KCl	CaCl ₂	
0.0	37.55	CaCl ₂ ·6H ₂ O
0.69	37.41	"
1.96	37.36	" + KCl
2.62	33.42	KCl
3.88	25.89	"
6.48	20.03	"
8.38	16.43	"
12.78	10.52	"
16.93	5.54	"
21.87	0.0	"

Results at 20°

(Mazetti, 1929)

Gms. per 100 gms. sat. sol.		Solid Phase
KCl	CaCl ₂	
0.0	42.7	CaCl ₂ ·6H ₂ O
0.63	43.8	" + KCl
1.19	35.78	KCl
2.54	30.70	"
6.8	19.80	"
10.62	14.14	"
19.41	6.21	"
25.40	0.0	"

(Cont.)

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - POTASSIUM CHLORIDE - WATER--Cont.

	Results at 25° (Lee and Egerton, 1923)			Results at 30° (Barbuddy, 1923)		
	Gms. per 100 sat. sol.		Solid Phase	Gms. per 100 sat. sol.		Solid Phase
	CaCl ₂	KCl		CaCl ₂	KCl	
d ₂₅ of						
sol.						
1.47	45.06	0.0	CaCl ₂ ·6H ₂ O	50.0	0.3	CaCl ₂ ·4H ₂ O
...	44.73	3.28	"	49.6	2.1	"
1.485	44.72	3.06	"	49.5	3.35	"
1.485	44.66	3.05	" + KCl	49.2	4.4	" + KCl
Cl 1.402	37.82	3.15	KCl	46.8	4.0	KCl
1.349	32.34	3.72	"	30.3	4.85	"
1.273	23.15	7.52	"	24.0	7.9	"
1.236	16.55	11.64	"	16.0	12.85	"
1.204	8.53	17.63	"	9.25	18.5	"
1.182	0.00	26.74	"	2.33	24.8	"

Results at 35° (Lightfoot and Prutton, 1946)			Results at 50° (Assarsson, 1950)		
Gms. per 100 sat. sol.		Solid Phase	Gms. per 100 sat. sol.		Solid Phase
CaCl ₂	KCl		CaCl ₂	KCl	
0.0	28.04	KCl	0.0	29.9	KCl
3.12	24.66	"	5.9	24.9	"
7.28	20.77	"	12.7	18.1	"
13.37	15.59	"	23.8	9.8	"
19.75	10.77	"	30.9	6.1	"
26.45	6.89	"	39.0	4.8	"
31.56	4.89	"	45.7	5.7	"
38.37	3.74	"	48.9	6.6	"
43.56	4.25	"	50.85	8.60	" + CaCl ₂ ·KCl
46.48	4.90	"	50.75	8.65	" "
47.65	5.10	"	51.6	7.1	CaCl ₂ ·KCl
50.47	6.48	" + CaCl ₂ ·4H ₂ Oα	52.1	6.6	"
50.43	6.48	" "	52.9	6.0	"
50.70	3.26	CaCl ₂ ·4H ₂ Oα	53.8	5.6	"
51.02	1.28	"	54.8	4.6	"
51.06	0.82	"	55.51	5.10	" + CaCl ₂ ·2H ₂ O
51.33	0.0	"	55.58	4.09	CaCl ₂ ·2H ₂ O
			56.56	0.0	"

Results at 55° (Sveshnikova, 1952)			Results at 95° (Assarsson, 1950)		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	KCl		CaCl ₂	KCl	
55.26	4.63	CaCl ₂ ·2H ₂ O	0.0	36.2	KCl **
56.40	4.46	" + KCl·CaCl ₂	6.4	29.2	"
49.35	7.79	KCl·CaCl ₂ + KCl	11.3	24.2	"
40.18	5.11	KCl	18.0	18.6	"
(Cont.)			(Cont.)		

THE SYSTEM CALCIUM CHLORIDE - POTASSIUM CHLORIDE - WATER—Cont.

Results at 55°—Cont.
(Sveshnikova, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	KCl	
31.89	6.07	KCl
31.55	6.35	"
12.75	18.27	"
4.82	25.66	"

Results at 75°
(Lightfoot and Prutton, 1947)

0.0	33.16	KCl
11.73	21.62	"
18.27	16.00	"
28.47	9.62	"
37.65	6.77	"
42.84	6.97	"
47.64	8.43	"
50.20	10.33	" + 2KCl.CaCl ₂ .2H ₂ O
50.34	10.36	2KCl.CaCl ₂ .2H ₂ O
50.92	9.36	"
53.85	6.21	"
54.03	6.08	"
54.52	5.45	"
54.79	5.55	"
56.33	4.51	"
56.28	4.33	"
56.57	4.20	"
56.79	4.00	"
57.00	3.92	"
57.66	3.59	" + CaCl ₂ .2H ₂ O
57.77	2.56	CaCl ₂ .2H ₂ O
58.58	0.0	"

Results at 95°—Cont.
(Assarsson, 1950)

Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	KCl	
28.0	12.7	KCl
38.4	10.5	"
41.3	10.3	"
43.2	10.2	"
45.3	10.5	"
48.0	11.9	"
48.6	12.2	"
49.6	12.4	" + CaCl ₂ .KCl
49.9	12.1	CaCl ₂ .KCl
52.2	9.3	"
53.0	8.0	"
54.0	7.2	"
55.6	5.9	"
56.4	5.3	"
58.3	3.9	"
59.6	2.9	" + CaCl ₂ .2H ₂ O
59.8	2.5	CaCl ₂ .2H ₂ O
60.20	0.0	"

Results at 95°
(Lightfoot and Prutton, 1947)

49.47	12.42	KCl + 2KCl.CaCl ₂ .2H ₂ O
49.40	12.44	" "
52.47	7.25	2KCl.CaCl ₂ .2H ₂ O
58.26	3.93	" + CaCl ₂ .2H ₂ O

THE SYSTEM CALCIUM CHLORIDE - SODIUM CHLORIDE - WATER

Results of Yanatieva, 1946 below 0°

The author presents a diagram showing the phases present at all compositions and temperatures below 55° and gives data at constant temperature and at constant ratios of CaCl₂:NaCl. The ternary eutectic temperature is -52.0°, and the results at 0° and 25° agree fairly well with those of previous workers.

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - SODIUM CHLORIDE - WATER--Cont.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CaCl ₂	NaCl	Solid Phase	CaCl ₂	NaCl	Solid Phase
Results at -5°			Results at -25°		
8.40	0.0	Ice	20.40	3.60	Ice
7.60	1.20	"	12.30	12.80	"
4.40	4.60	"	11.20	13.80	" + NaCl.2H ₂ O
0.0	7.40	"	12.80	13.40	NaCl.2H ₂ O
0.0	25.60	NaCl.2H ₂ O	24.80	4.20	"
4.80	21.20	" + NaCl	29.80	2.20	"
C) 13.80	14.80	NaCl	32.60	1.30	"
26.40	4.60	"	32.80	1.40	" + CaCl ₂ .6H ₂ O
30.80	2.42	"			
33.80	1.40	"			
Results at -10°			Results at -30°		
13.00	2.20	Ice	24.20	1.00	Ice
7.80	8.20	"	23.80	1.80	"
0.0	13.50	"	22.00	3.80	"
0.0	25.00	NaCl.2H ₂ O	19.60	7.00	" + NaCl.2H ₂ O
13.40	14.20	"	24.70	1.20	NaCl.2H ₂ O
24.00	5.80	" + NaCl	29.40	2.20	"
26.10	4.30	NaCl	32.00	1.40	" + CaCl.6H ₂ O
30.70	2.40	"			
33.80	1.20	" + CaCl ₂ .6H ₂ O			
Results at -15°			Results at -35°		
16.20	2.60	Ice	25.80	1.00	Ice
10.00	10.50	"	25.60	1.80	"
0.0	19.00	"	23.80	4.00	"
0.0	24.40	NaCl.2H ₂ O	23.50	4.50	" + NaCl.2H ₂ O
13.00	13.80	"	24.20	4.20	NaCl.2H ₂ O
25.80	4.80	" + NaCl	28.80	2.20	"
30.65	2.36	NaCl	31.60	1.45	" + CaCl ₂ .6H ₂ O
33.60	1.40	"			
33.70	1.30	" + CaCl ₂ .6H ₂ O			
Results at -20°			Results at -40°		
18.40	3.20	Ice	27.20	1.00	Ice
11.40	12.00	"	26.80	2.00	"
0.0	22.40	"	26.20	3.10	" + NaCl.2H ₂ O
0.0	23.60	NaCl.2H ₂ O	28.60	2.10	NaCl.2H ₂ O
12.90	13.60	"	31.00	1.50	" + CaCl ₂ .6H ₂ O
25.40	4.40	"			
29.00	3.00	" + NaCl			
30.60	2.30	NaCl			
33.30	1.30	"			
33.40	1.35	" + CaCl ₂ .6H ₂ O			
Results at -45°					
			28.60	1.20	Ice
			27.80	2.20	"
			27.40	2.50	" + NaCl.2H ₂ O
			28.30	2.20	NaCl.2H ₂ O
			30.30	1.60	" + CaCl ₂ .6H ₂ O
			30.40	1.20	CaCl ₂ .6H ₂ O

(Cont.)

THE SYSTEM CALCIUM CHLORIDE - SODIUM CHLORIDE - WATER—Cont.

Results at 0°

(Igelsrud and Thompson, 1936)

Gms. per 100
gms. sat. sol.

CaCl ₂	NaCl	Solid Phase
37.55	0.0	CaCl ₂ ·6H ₂ O
37.50	0.31	" + NaCl
35.31	0.93	NaCl
27.14	3.59	"
20.60	7.78	"
16.12	11.36	"
9.53	17.28	"
5.33	21.19	"
0.0	26.42	NaCl·2H ₂ O

(Yanatieva, 1946)

Gms. per 100
gms. sat. sol.

CaCl ₂	NaCl	Solid Phase
0.0	26.23	NaCl
13.80	14.60	"
26.60	4.60	"
31.40	2.60	"
34.40	1.40	"
37.60	1.10	" + CaCl ₂ ·6H ₂ O

Cl

Results at 25°

(Cameron, Bell and Robinson, 1907)

Gms. per 100
gms. H₂O

d ₂₅ Sat. Sol.	CaCl ₂	NaCl	Solid Phase
....	84	0	CaCl ₂ ·6H ₂ O
1.4441	78.49	1.846	" + NaCl
1.3651	48.58	1.637	NaCl
1.3463	53.47	1.799	"
1.2831	36.80	7.77	"
1.2653	30.08	10.70	"
1.2367	19.53	18.85	"
1.2080	3.92	32.48	"
1.2030	0	35.80	"

(Yanatieva, 1946)

Gms. per 100
gms. sat. sol.

CaCl ₂	NaCl	Solid Phase
45.60	0.0	CaCl ₂ ·6H ₂ O
0.0	26.80	NaCl
27.30	4.70	"
32.40	2.80	"
35.60	1.40	"
43.50	1.00	" + CaCl ₂ ·6H ₂ O

Results at 50°

(Pelling and Robertson, 1913)

Gms. per 100
gms. sat. sol.

CaCl ₂	NaCl	Solid Phase
57.0	0.0	CaCl ₂ ·2H ₂ O
56.3	0.9	" + NaCl
30.9	3.6	NaCl
15.1	13.2	"
3.3	24.4	"
0.0	26.8	"

Results at 94°.5

(Pelling and Robertson, 1913)

Gms. per 100
gms. sat. sol.

CaCl ₂	NaCl	Solid Phase
58.1	0.8	CaCl ₂ ·2H ₂ O + NaCl
57.4	1.1	NaCl
45.7	1.3	"
32.8	4.3	"
15.3	15.0	"
11.5	18.1	"

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER BELOW 0°
(Yanatieva, 1946; Prutton and Tower, 1932; Igelsrud and Thompson, 1936)

Gms. per 100 gms. Sat. Sol.			Gms. per 100 gms. Sat. Sol.		
CaCl ₂	MgCl ₂	Solid Phase	CaCl ₂	MgCl ₂	Solid Phase
Results at 0°					
	(Y.)			(P. & T.)	(I. & T.)
0.0	34.80	MgCl ₂ .6H ₂ O	37.44	0.0	CaCl ₂ .6H ₂ O
14.00	23.50	" + CaCl ₂ .6H ₂ O	30.22	6.82	"
18.50	18.50	CaCl ₂ .6H ₂ O	27.17	9.81	"
27.80	9.40	"	25.10	11.95	"
35.20	2.60	"	22.12	14.94	"
37.26	0.0	"	14.89	22.83	"
			13.88	23.83	" + MgCl ₂ .6H ₂ O
			13.87	23.91	MgCl ₂ .6H ₂ O
			5.84	29.91	"
			5.70	30.04	"
			4.51	30.89	"
			0.0	34.62	"
Results at -5° (Y.)					
8.40	0.0	Ice	14.80	0.0	Ice
8.20	0.70	"	14.20	1.00	"
6.40	2.20	"	10.80	3.60	"
4.60	4.60	"	7.00	7.00	"
0.0	7.40	"	0.0	11.60	"
0.0	34.40	MgCl ₂ .6H ₂ O	0.0	33.60	MgCl ₂ .8H ₂ O
10.60	26.00	" + CaCl ₂ .6H ₂ O	10.40	25.40	" + CaCl ₂ .6H ₂ O
17.80	17.80	CaCl ₂ .6H ₂ O	17.60	17.60	CaCl ₂ .6H ₂ O
27.20	9.10	"	26.60	8.80	"
34.40	2.20	"	33.60	2.20	"
36.20	0.0	"	35.50	0.0	"
Results at -10° (Y.)					
18.50	0.0	Ice	0.0	34.78	CaCl ₂ .6H ₂ O
17.20	1.20	"	2.83	31.92	"
13.20	4.40	"	3.90	30.50	"
8.50	8.50	"	11.97	22.42	"
0.0	14.60	"	24.14	10.73	" MgCl ₂ .8H ₂ O*
0.0	32.60	MgCl ₂ .8H ₂ O	25.71	9.43*	CaCl ₂ .6H ₂ O
10.78	24.21	" + CaCl ₂ .6H ₂ O	28.07	7.52*	" + MgCl ₂ .6H ₂ O
17.40	17.40	CaCl ₂ .6H ₂ O	29.98	5.11*	MgCl ₂ .6H ₂ O
26.00	8.60	"	33.86	0.0*	"
32.80	2.10	"	25.68	8.67	MgCl ₂ .8H ₂ O*
34.50	0.0	"	26.15	7.70	"
			27.17	6.46	"
			28.70	4.42	"
			31.85	0.0	"
			0.0	12.23	Ice
			14.69	0.0	"
			10.85	5.0	"
			4.01	13.35	"

*Metastable

(Cont.)

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER BELOW 0°--Cont.

Gms. per 100 gms. Sat. Sol.			Gms. per 100 gms. Sat. Sol.		
CaCl ₂	MgCl ₂	Solid Phase	CaCl ₂	MgCl ₂	Solid Phase
Results at -20° (Y.)			Results at -25° (Y.)		
21.00	0.0	Ice	23.50	0.0	Ice
20.00	1.30	"	21.80	1.40	"
15.00	5.00	"	16.60	5.60	"
9.60	9.60	"	10.60	10.60	"
0.0	16.80	"	0.0	18.80	"
0.0	26.60	MgCl ₂ .12H ₂ O	0.0	24.30	MgCl ₂ .12H ₂ O
17.20	17.20	CaCl ₂ .6H ₂ O	16.30	17.40	" + CaCl ₂ .6H ₂ O
25.40	8.40	"	16.90	16.90	CaCl ₂ .6H ₂ O
32.20	2.00	"	25.00	8.40	"
34.00	0.0	"	31.60	2.10	"
			33.60	0.0	"

Results at -30°					
(Y.)			(P. & T.)		
25.00	0.0	Ice	32.92	0.0	CaCl ₂ .6H ₂ O
23.60	1.60	"	30.07	2.50	"
18.00	6.00	"	27.04	5.49	"
11.40	11.40	"	23.55	8.61	" + MgCl ₂ .12H ₂ O
0.0	24.40	"	19.78*	12.26	CaCl ₂ .6H ₂ O
0.0	22.50	MgCl ₂ .12H ₂ O	15.23*	16.76	"
15.80	15.80	" + CaCl ₂ .6H ₂ O	7.40*	25.55	"
18.20	15.20	CaCl ₂ .6H ₂ O	6.14*	27.20	"
24.60	8.20	"	19.13	9.94	MgCl ₂ .12H ₂ O
31.20	2.00	"	19.44	10.20	"
33.40	0.0	"	11.39	14.70	"
			11.27	14.65	"
			7.63	16.99	"
			0.0	22.19	"
			0.0	20.47	Ice
			4.83	16.45	"
			6.18	17.16	"
			25.03	0.0	"
Results at -35° (Y.)			Results at -40° (Y.)		
26.60	0.0	Ice	28.20	0.0	Ice
25.00	1.60	"	26.40	1.70	"
19.20	6.40	"	20.30	6.70	"
12.20	12.20	"	12.70	12.70	"
8.00	16.40	" + MgCl ₂ .12H ₂ O	11.00	14.40	" + MgCl ₂ .12H ₂ O
14.30	14.30	MgCl ₂ .12H ₂ O	13.40	13.40	MgCl ₂ .12H ₂ O
21.00	11.60	" + CaCl ₂ .6H ₂ O	23.40	8.80	" + CaCl ₂ .6H ₂ O
24.30	8.10	CaCl ₂ .6H ₂ O	24.00	8.10	CaCl ₂ .6H ₂ O
30.60	2.00	"	30.00	1.95	"
32.40	0.0	"	32.00	0.0	"
Results at -45° (Y.)					
29.50	0.0	Ice			
27.60	1.60	"			
21.10	6.00	"			
17.10	10.40	" + MgCl ₂ .12H ₂ O			
22.60	7.50	MgCl ₂ .12H ₂ O			
25.00	6.50	" + CaCl ₂ .6H ₂ O			
29.40	1.90	CaCl ₂ .6H ₂ O			
31.80	0.0	"			

Y. = Yanatieva, 1946
P.&T. = Prutton and Tower, 1932

(Cont.)

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER BELOW 0°--Cont.

		Other Temperatures	
Y. = Yanatieva, 1946		P. and T. = Prutton and Tower, 1932	
Gms. per 100 gms. sat. sol.			
t°	CaCl ₂ MgCl ₂	Solid Phase	
(-49.8°)	30.40 0.0	Ice + CaCl ₂ .6H ₂ O	
(-51.7°)	28.86 2.08	"	
(-55.0°)	26.00 5.00	Ice + CaCl ₂ .6H ₂ O + MgCl ₂ .12H ₂ O	
(-52.2°)	27.40 2.93	" + " + "	
Cl (-20.7°)	10.56 23.23	CaCl ₂ .6H ₂ O + MgCl ₂ .12H ₂ O + MgCl ₂ .8H ₂ O ₂	
(-6.7°)	9.90 26.40	CaCl ₂ .6H ₂ O + MgCl ₂ .8H ₂ O + MgCl ₂ .6H ₂ O	
(-50.2°)	21.50 7.30	Ice + MgCl ₂ .12H ₂ O	
(-43.0°)	13.0 13.00	"	
(-33.6°)	0.0 21.38	"	

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER ABOVE 0°

Results of Yanatieva, 1946 at 15°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	MgCl ₂		CaCl ₂	MgCl ₂	
0.0	35.50	MgCl ₂ .6H ₂ O	31.00	10.60	CaCl ₂ .6H ₂ O
20.30	20.30	"	38.60	2.80	"
22.60	18.40	" + CaCl ₂ .6H ₂ O	41.20	0.0	"

Results of Lee and Egerton, 1923 at 25°

The results of Kurnakov and Nikolaev, 1938 are in good agreement.

Gms. per D ₂₅ of 100 gms. sat. sol.		Solid Phase	Gms. per d ₂₅ of 100 gms. sat. sol.		Solid Phase
Sat. Sol.	CaCl ₂ MgCl ₂		Sat. Sol.	CaCl ₂ MgCl ₂	
1.470	45.06 0.0	CaCl ₂ .6H ₂ O	1.455	31.17 14.54	1.2.12 + MgCl ₂ .6H ₂ O
1.465	41.87 4.06	"	1.441	28.12 16.31	MgCl ₂ .6H ₂ O
1.472	38.95 7.93	"	1.428	25.09 18.13	"
1.486	38.70 9.43	" + 1.2.12	1.391	16.05 23.33	"
1.473	36.37 10.78	1.2.12	1.371	10.33 27.61	"
1.460	32.82 13.55	"	1.341	0.0 35.54	"

1.2.12 = Tachhydrite = CaCl₂.2MgCl₂.12H₂O.

(Cont.)

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER ABOVE 0°—Cont.

The following results, differing in some respects from the above, were obtained by Bury and Davies (1933) at 25°.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Solid Phase
CaCl ₂	MgCl ₂	Solid Phase	CaCl ₂	MgCl ₂		
45.0	0.0*	C + Mg(OH) ₂	7.46	29.84*	3.1.11	
44.88	0.168*	C + Mg(OH) ₂	48.80	0.0	C4α	
44.55	0.612*	C + 3.1.11	46.49	2.739	"	
42.14	3.098	C	44.71	4.742	"	Cl
41.48	4.115	C	43.42	5.97	"	
39.58	6.47	C	43.38	6.01	"	
38.82	8.14*	C + 3.1.11	43.19	6.24	"	
38.80	9.42*	C + 1.2.12	41.99	7.30	"	
33.36	13.58*	3.1.11 + 1.2.12	40.03	8.52	"	
31.32	14.60*	" + " $\frac{1}{4}$ M	38.88	9.43	"	
22.29	19.32*	3.1.11 + M	38.94	9.38	"	
7.87	29.25*	3.1.11				

C = CaCl₂·6H₂O; 3.1.11 = 3MgO·MgCl₂·11H₂O; 1.2.12 = Tachhydrite, CaCl₂·2MgCl₂·12H₂O; M = MgCl₂·6H₂O; C4α = CaCl₂·4H₂Oα. *These solutions also contained 0.002 gms. MgO.

Data of Lightfoot and Prutton, 1946, 1947

Gms. per 100 gms. sat. sol.			Solid Phase
CaCl ₂	MgCl ₂	Results at 35°	
51.33	0.0	CaCl ₂ ·4H ₂ Oα	
49.09	2.10	"	
47.75	3.50	"	
45.03	6.20	" + CaCl ₂ ·2MgCl ₂ ·12H ₂ O	
45.03	6.20	" + "	
45.07	6.22	CaCl ₂ ·2MgCl ₂ ·12H ₂ O	
39.25	9.49	"	
35.64	11.88	"	
35.15	12.19	"	
30.06	15.67	"	
26.98	17.95	"	
26.78	18.04	"	
26.70	18.13	" + MgCl ₂ ·6H ₂ O	
26.66	18.24	" + "	
23.15	20.28	MgCl ₂ ·6H ₂ O	
18.89	23.17	"	
9.81	29.07	"	
3.63	33.56	"	
0.0	36.28	"	
Results at 75°			
58.58	0.0	CaCl ₂ ·2H ₂ O	
55.76	2.53	"	
52.59	5.27	" + CaCl ₂ ·2MgCl ₂ ·12H ₂ O	
52.57	5.28	CaCl ₂ ·2MgCl ₂ ·12H ₂ O	
45.01	8.74	CaCl ₂ ·2MgCl ₂ ·12H ₂ O	

(Cont.)

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER ABOVE 0°--Cont.

Data of Lightfoot and Prutton, 1946, 1947--Cont.

Results at 75°--Cont.

Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	MgCl ₂	
34.97	14.70	CaCl ₂ .2MgCl ₂ .12H ₂ O
29.15	18.63	"
19.28	25.55	"
13.83	29.65	"
12.52	30.59	"
10.15	32.39	"
9.97	32.59	"
8.31	33.90	" + MgCl ₂ .6H ₂ O
8.31	33.91	MgCl ₂ .6H ₂ O
8.04	34.07	MgCl ₂ .6H ₂ O
3.84	36.62	"
0.0	39.12	"

Results of Assarsson, 1950 at 110°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	MgCl ₂		CaCl ₂	MgCl ₂	
0.0	42.8	MgCl ₂ .6H ₂ O	49.0	9.5	1:1:12 + 1:2:6
2.0	41.4	" + 1:1:12	51.0	8.0	1:2:6
13.6	30.8	1:1:12	53.5	6.2	"
18.2	28.0	"	55.7	4.7	" + CaCl ₂ .2H ₂ O
26.9	21.2	"	56.8	4.0	CaCl ₂ .2H ₂ O
40.0	14.0	"	62.3	0.0	"
47.8	10.0	"			

1:1:12 = MgCl₂.CaCl₂.12H₂O 1:2:6 = MgCl₂.2CaCl₂.6H₂O.

Further data on the system CaCl₂ - MgCl₂ - H₂O at temperatures from 0° to 116° are given by Mulder (1864), Van't Hoff and Kenrick (1912), Assarsson (1950), and Zdanovskii (1949).

THE SYSTEM CaCl₂ + MgCl₂ + KCl + H₂O

Data for the system at 0° are given by Igelsrud and Thompson, 1936(a).

Results at 35°
(Lightfoot and Prutton, 1948)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
MgCl ₂	CaCl ₂	KCl		MgCl ₂	CaCl ₂	KCl	
27.33	0.0	3.81	C + K	5.83	31.66	3.38	C + K
20.61	9.12	3.69	" "	4.07	35.51	3.44	" "
10.59	23.57	3.47	" "	4.01	35.60	3.43	" "

(Cont.)

THE SYSTEM $\text{CaCl}_2 + \text{MgCl}_2 + \text{KCl} + \text{H}_2\text{O}$ —Cont.Results at 35°—Cont.
(Lightfoot and Prutton, 1948)Gms. per 100
gms. sat. sol.

	MgCl_2	CaCl_2	KCl	Solid Phase
	2.31	41.00	3.80	C + K
	1.30	45.85	4.71	" "
	1.15	48.34	5.69	" "
	1.17	48.89	6.04	" "
Av.	1.02	49.76	6.46	" + " + Ca_4
	36.17	0.0	0.14	C + Mg_6
	26.66	12.97	0.16	" "
Av.	18.07	26.74	0.23	" + " + T
	14.23	32.01	0.32	C + T
	13.83	32.60	0.33	" "
	7.28	42.75	0.71	" "
	6.98	43.27	0.76	" "
	6.15	44.44	0.97	" "
Av.	5.91	45.30	0.99	C + Ca_4 + T
	4.42	46.56	1.33	C + Ca_4
	2.69	48.40	2.28	" "
	1.72	49.25	3.92	" "
	1.36	49.54	5.10	" "
	0.0	50.45	6.48	K + Ca_4
	0.71	50.06	6.46	" "
	0.93	49.83	6.45	" "
	6.20	45.03	0.0	T + Ca_4
	6.13	45.18	0.33	" "
	5.82	45.43	0.70	" "
	18.18	26.68	0.0	T + Mg_6
	*4.34	48.18	1.41	C + T
	*4.22	48.63	1.53	" "
	*3.97	49.24	1.64	" "
Av.	*3.39	50.49	2.10	" + " + Ca_4
	*3.06	50.81	2.10	C + Ca_4
	*2.05	51.78	3.91	" "
	*1.51	52.05	4.53	" "
Av.	*0.89	50.70	7.01	C + K + Ca_4

Results at 75°
(Lightfoot and Prutton, 1949)Gms. per 100
gms. sat. sol.

	MgCl_2	CaCl_2	KCl	Solid Phase
	29.26	0.0	5.57	C + K
	23.14	8.56	5.56	" "
	16.71	18.07	5.61	" "
	10.89	27.57	5.85	" "
	6.39	36.76	6.73	" "
	4.48	41.95	7.81	" "
	3.85	44.63	8.80	" "
	3.47	46.31	9.70	" + " + D
	38.86	0.0	0.32	C + Mg_6
	36.20	4.26	.38	" "
	33.68	8.40	.39	" + " + T
	26.95	16.96	.67	C + T
	16.12	32.00	1.58	" "
	7.92	44.90	3.68	" "
	6.76	46.43	5.11	" + " + D
	5.58	46.69	6.25	C + D
	0.0	57.66	3.59	Ca_2 + D
	1.85	55.23	3.35	" "
	5.28	52.58	0.0	Ca_2 + T
	4.66	52.47	2.65	" "
	4.55	52.51	3.07	" + " + D
	4.51	52.29	3.19	T + D
	4.97	51.21	3.44	" "
	5.44	50.06	3.81	" "
	6.68	46.63	5.02	" "
	0.0	51.20	10.33	K + D
	2.71	47.32	9.84	" "
	33.91	8.31	0.0	T + Mg_6

C = $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ T = $\text{CaCl}_2 \cdot 2\text{MgCl}_2 \cdot 12\text{H}_2\text{O}$ Ca_4 = $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$

Av. = Average

* = Metastable

K = KCl

D = $2\text{KCl} \cdot \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ Ca_2 = $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ Mg_6 = $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ THE SYSTEM $\text{CaCl}_2 + \text{MgCl}_2 + \text{NaCl} + \text{H}_2\text{O}$ AT 25°
(Kurnakov and Nikolaev, 1938)

The authors present data for the system $\text{CaCl}_2 + \text{MgCl}_2 + \text{H}_2\text{O}$ at 25° which agrees very closely with those of Lee and Egerton (p. 583) and add the following quaternary data:

Ca CALCIUM

THE SYSTEM $\text{CaCl}_2 + \text{MgCl}_2 + \text{NaCl} + \text{H}_2\text{O}$ AT 25° —Cont.

Gms. CaCl_2 per 100 gms. Sat. Sol.	Gms. MgCl_2 per 100 gms. Sat. Sol.	Gms. NaCl per 100 gms. Sat. Sol.	Solid Phases
38.83	9.56	0.30	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + 2\text{MgCl}_2 \cdot \text{CaCl}_2 \cdot 12\text{H}_2\text{O} + \text{NaCl}$
30.50	14.95	0.38	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O} + 2\text{MgCl}_2 \cdot \text{CaCl}_2 \cdot 12\text{H}_2\text{O} + \text{NaCl}$
23.40	19.15	0.32	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O} + \text{NaCl}$
10.44	27.70	0.32	"

Cl

THE SYSTEM $\text{CaCl}_2 + \text{NaCl} + \text{KCl} + \text{H}_2\text{O}$
(Assarsson, 1950)

Gms. per 100 gms. Sat. Sol.			Solid Phase	Gms. per 100 gms. Sat. Sol.			Solid Phase
CaCl ₂	KCl	NaCl		CaCl ₂	KCl	NaCl	
Results at 18°							
0.0	0.0	26.5	Na	25.3	4.8	4.0	K + Na
0.0	25.1	0.0	K	29.7	3.7	2.1	"
0.0	10.0	20.8	K + Na	40.80	2.65	0.45	" + Ca6
6.0	9.3	16.0	"	41.60	0.0	0.42	Ca6 + Na
11.8	8.1	12.4	"	40.95	2.70	0.0	Ca6 + K
17.6	6.8	8.4	"	42.05	0.0	0.0	Ca6
22.7	5.5	5.4	"				
Results at 50°							
0.0	0.0	27.0	Na	0.0	0.0	28.3	Na
0.0	31.6	0.0	K	0.0	37.6	0.0	K
0.0	14.7	19.1	K + Na	0.0	21.0	17.0	K + Na
6.0	13.0	16.0	"	4.7	18.5	14.2	"
11.6	11.2	11.9	"	9.7	15.3	13.3	"
17.6	9.5	8.5	"	14.5	13.0	11.0	"
22.7	7.8	6.0	"	19.4	10.6	8.2	"
33.9	5.5	2.2	"	24.3	9.3	4.9	"
39.2	5.0	0.7	"	33.8	8.4	2.3	"
44.8	5.6	.5	"	37.7	8.0	1.8	"
48.5	7.1	.5	"	41.4	8.0	1.6	"
51.00	8.25	.49	K + 1:1 + Na	48.8	12.1	1.2	"
50.90	8.45	.47	"	49.4	12.5	1.1	K + 1:1 + Na
51.70	7.45	.46	1:1 + Na	49.9	12.1	1.1	1:1 + Na
52.65	6.50	.45	"	50.3	11.4	1.1	"
53.85	5.35	.45	"	51.9	9.1	1.0	"
54.25	4.85	.44	"	52.9	8.2	0.9	"
55.30	4.20	.44	1:1 + Ca2 + Na	53.6	7.4	.9	"
55.35	4.10	.44	"	55.6	5.7	.9	"
55.50	4.10	0.0	1:1 + Ca2	57.4	4.6	.9	"
55.40	4.05	.44	Ca2 + Na	58.1	3.9	.9	"
56.45	0.0	.64	"	58.8	3.2	.9	1:1 + Ca2 + Na
56.40	0.0	.61	"	59.6	2.9	0.0	1:1 + Ca2
56.55	0.0	0.0	Ca2	58.9	2.8	.9	Ca2 + Na
Na = NaCl				60.10	0.0	.98	"
K = KCl				60.20	0.0	0.0	Ca2
Ca2 = CaCl ₂ ·2H ₂ O	Ca6 = CaCl ₂ ·6H ₂ O			1:1 = CaCl ₂ ·KCl			(Cont.)

(Cont.)

THE SYSTEM $\text{CaCl}_2 + \text{NaCl} + \text{KCl} + \text{H}_2\text{O}$ —Cont.

Results at Other Temperatures

In addition to the results above, Assarsson, 1950 gives data between 26° and 43°. Data at 25° are given by Zhdanovskii, 1948. The following data are those of Yanatieva, 1947.

t°	Density	Gms. per 100 gms. sat. sol.			Solid Phases
		KCl	NaCl	CaCl_2	
0	1.391	2.15	0.49	36.37	KCl + NaCl + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ Cl
25	1.250	9.59	14.06	7.62	" + "
25	1.274	7.49	9.74	14.95	" + "
25	1.469	3.22	0.62	44.82	" + " + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
50	1.266	18.27	20.74	8.48	" + "
50	1.299	9.38	7.53	17.84	" + "
50	1.516	5.47	1.15	45.24	" + "
50	1.805	4.19	0.50	55.28	" + " + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$

Data for the system $\text{CaCl}_2 + \text{MgCl}_2 + \text{SrCl}_2 + \text{KCl} + \text{NaCl} + \text{water}$ at temperatures of from 18° to 93° are given by Assarsson and Balder, 1955.

Data for the five-component system $\text{CaCl}_2 + \text{MgCl}_2 + \text{KCl} + \text{NaCl} + \text{H}_2\text{O}$ at 35° are given by Meyer, Prutton, and Lightfoot, 1949.

Data for equilibrium in the reaction $\text{CaCl}_2 + 2\text{KClO}_3 \rightleftharpoons 2\text{KCl} + \text{Ca}(\text{ClO}_3)_2$ in aqueous solution at 15° and at 45° are given by Osaka and Nishio (Takesuye), 1930.

EQUILIBRIUM IN AQUEOUS SOLUTIONS SIMULTANEOUSLY SATURATED WITH
CALCIUM AND POTASSIUM CHLORIDES AND NITRATES AT -10°
(Kritschewski and Izkowitsch, 1933)

Gm. equiv. per 1000 gms. H_2O					Solid Phase
$\frac{1}{2}\text{CaCl}_2$	$\frac{1}{2}\text{Ca}(\text{NO}_3)_2$	KCl	KNO_3		
8.923	8.254	...	...		$\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
7.595	....	0.715	...		" + KCl
6.353	....	0.306	1.616		" + " + KNO_3
7.040	7.208	...	2.985		" + $\text{Ca}(\text{NO}_3)_2 + \text{KNO}_3$
...	13.192	...	2.571		" + "
...	....	3.314	0.575		KCl + KNO_3

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS
OF POTASSIUM BICHROMATE AT 25°
(Herz and Hiebenthal, 1929)

Gm. Mols. per liter		Gm. Mols. per liter	
$\frac{1}{2}\text{CaCl}_2$	$\frac{1}{6}\text{K}_2\text{Cr}_2\text{O}_7$	$\frac{1}{2}\text{CaCl}_2$	$\frac{1}{6}\text{K}_2\text{Cr}_2\text{O}_7$
11.45	0.0	11.48	0.25
11.34	0.10	11.36	0.35
11.38	0.16	11.42	1.88

Ca CALCIUM

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM
NITRATE AT 30° AND VICE VERSA
(Barbaudy, 1923)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CaCl ₂	KNO ₃		CaCl ₂	KNO ₃	
Cl	50.4	3.67	CaCl ₂ ·4H ₂ O	26.2	14.2	KCl
	50.7	5.1	"	24.2	17.6	"
	50.7	5.2	" + KCl	22.7	19.8	"
	50.3	5.2	KCl	21.8	21.5	"
	42.5	5.42	"	20.3	24.6	"
	38.3	5.82	"	19.8	25.3	"
	34.8	6.4	"	19.6	26.0	" + KNO ₃
	31.1	7.64	"	19.4	26.0	KNO ₃
	29.9	10.3	"	17.8	25.9	"
	28.6	11.9	"	14.37	26.3	"
	27.8	12.4	"	11.3	27.0	"
	36.9	13.5	"	9.5	27.6	"

THE SYSTEM CALCIUM CHLORIDE - LITHIUM CHLORIDE - WATER
(Blidin, 1954)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
LiCl	CaCl ₂	Solid Phase	LiCl	CaCl ₂	Solid Phase
Results at 25°			Results at 40°		
45.98	0.0	LiCl·H ₂ O	47.98	0.0	LiCl·H ₂ O
42.47	30.8	"	44.01	6.13	"
36.66	8.02	"	39.08	12.12	"
24.64	19.48	"	34.12	20.30	"
20.51	24.72	CaCl ₂ ·2H ₂ O	29.46	27.58	"
17.22	28.31	"	28.05	29.54	CaCl ₂ ·2H ₂ O + LiCl·H ₂ O
12.13	34.97	"	26.63	30.82	CaCl ₂ ·2H ₂ O
8.30	39.23	CaCl ₂ ·4H ₂ O	23.87	32.35	"
5.45	41.62	"	17.48	38.06	"
3.78	42.54	"	13.27	42.18	"
0.0	46.15	CaCl ₂ ·6H ₂ O	5.41	50.19	"
			2.54	53.10	CaCl ₂ ·4H ₂ O + CaCl ₂ ·2H ₂ O
			1.67	54.20	CaCl ₂ ·4H ₂ O
			0.0	55.84	"

THE SYSTEM CALCIUM CHLORIDE - STRONTIUM CHLORIDE - WATER
(Assarsson and Balder, 1953)

The salts from solid solutions. Results at 28°, 28.5°, 29.3°, 29.7°, and at several other temperatures between 44 and 114° are also given.

(Cont.)

THE SYSTEM CALCIUM CHLORIDE - STRONTIUM CHLORIDE - WATER--Cont.

Sat. Sol. wt. %		Wet Residue wt. %		Solid Phase	Sat. Sol. wt. %		Wet Residue wt. %		Solid
SrCl ₂	CaCl ₂	SrCl ₂	CaCl ₂		SrCl ₂	CaCl ₂	SrCl ₂	CaCl ₂	
Results at 18°					Results at 29°				
34.15	0.0	...	...	A	36.8	0.0	...	...	A
26.9	6.6	...	...	F	20.0	16.0	55.0	2.0	F
18.0	14.6	...	...	F	6.4	30.6	39.1	12.0	F
4.0	31.2	42.0	10.5	F	2.8	39.1	34.9	19.1	F
3.0	33.3	41.2	12.2	F	2.0	40.6	33.0	21.0	F
2.1	35.5	40.3	13.6	F	2.9	41.6	58.7	13.1	B
1.9	37.7	27.6	22.4	F	2.5	42.0	55.0	15.0	B
1.4	38.7	22.5	28.4	F	2.5	42.5	57.7	14.5	B
1.1	39.7	18.9	31.2	F	1.7	44.0	59.7	11.7	B
0.7	40.4	10.0	40.6	F	1.7	44.3	54.6	15.5	B
0.5	40.6	5.0	43.0	F	1.6	44.6	9.6	41.2	F
0.4	41.2	1.5	46.0	F	1.4	45.2	8.2	42.6	F
0.3	41.4	1.0	48.9	F	1.4	45.8	5.8	44.8	F
0.0	42.05	...	...	C	1.1	46.8	2.6	47.2	F
					0.9	47.7	1.9	48.7	F
					0.2	48.7	0.5	49.0	F
					0.0	49.2	...	49.8	C
Results at 60°					Results at 100°				
46.2	0.0	...	...	A	50.8	0.0	...	...	B
45.5	0.8	58.0	0.2	F	33.7	15.2	63.8	7.0	G
45.0	1.4	62.4	0.2	F + B	22.4	26.0	60.2	11.2	G
43.3	2.9	72.1	0.5	B	9.5	39.8	...	...	G
40.0	5.6	62.0	2.6	B	5.1	51.0	51.3	25.2	G
37.0	8.0	66.0	2.5	B	3.9	54.4	42.6	31.1	G
33.0	11.4	68.2	3.3	B	2.9	58.7	53.1	26.2	G
18.8	23.7	...	...	B	2.7	59.1	3.6	67.1	E + G
8.5	34.3	...	...	B	2.5	59.4	1.4	68.1	E
3.3	43.2	...	...	B	0.0	61.3	...	70.0	E
1.7	52.5	36.0	30.0	B					
1.0	57.0	39.9	29.0	B					
1.0	57.1	38.2	40.6	B + E					
0.8	57.6	0.6	70.3	E					
0.0	58.2	...	69.7	E					

A = SrCl₂·6H₂O
B = SrCl₂·2H₂O
C = CaCl₂·6H₂O

D = CaCl₂·4H₂O
E = CaCl₂·2H₂O
F = Solid solution of CaCl₂·6H₂O + SrCl₂·6H₂O

G = SrCl₂·H₂O

Cl

G

A = SrCl₂·6H₂OD = CaCl₂·4H₂OG = SrCl₂·H₂OB = SrCl₂·2H₂OE = CaCl₂·2H₂OC = CaCl₂·6H₂OF = Solid solution of CaCl₂·6H₂O + SrCl₂·6H₂O

Results for the system CaCl₂ + SrCl₂ + KCl + H₂O between 18° and 100° are given by Assarsson and Balder, 1954.

Ca CALCIUM

THE SYSTEM CALCIUM CHLORIDE - ZINC CHLORIDE - WATER (Tschischikoff and Schachoff, 1936)

Results at 25°			Results at 60°		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
ZnCl ₂	CaCl ₂	Solid Phase*	ZnCl ₂	CaCl ₂	Solid Phase*
0.0	52.0	CaCl ₂	0.0	57.8	CaCl ₂
23.6	43.33	"	6.40	50.42	"
28.80	41.35	"	13.05	46.99	"
53.11	24.19	"	34.42	34.41	"
61	60.56	" + ZnCl ₂	41.7	27.55	"
81.0	0.0	ZnCl ₂	50.19	28.30	" + ZnCl ₂
			47.6	27.09	"
			63.87	15.92	ZnCl ₂
			76.09	6.58	"
			79.89	3.67	"
			80.49	2.01	"
			81.52	0.90	"
			83.0	0.0	"

*The degrees of hydration of the solid phases were not given.

A few crystallization temperatures (below 0°) in the system CaCl₂ + ZnCl₂ + H₂O in the presence of 10% NH₄Cl are given by Otto, 1951.

THE SYSTEM CALCIUM CHLORIDE - SUCROSE - WATER

A phase diagram is given by Kelly, 1954. No compounds are formed. A solution saturated with sucrose + CaCl₂·6H₂O contains

{ 47.6% sucrose and 24.9% CaCl₂ at 30° (Kelly)
42.84% " " 25.25% " at 31.23° (Kohler, 1897)

THE SYSTEM CALCIUM CHLORIDE - UREA - WATER (De Carli, 1932a)

Results at 11°			Results at 25°		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CO(NH ₂) ₂	CaCl ₂	Solid Phase	CO(NH ₂) ₂	CaCl ₂	Solid Phase
0.0	38.80	CaCl ₂ ·6H ₂ O	0.0	45.97	CaCl ₂ ·6H ₂ O
5.90	39.35	"	4.52	45.22	"
9.50	39.90	" + 1.4.2	6.66	45.03	"
17.59	32.55	1.4.2	13.27	43.99	" + 1.4
16.51	28.75	"	17.41	38.37	1.4
26.77	23.56	"	29.77	27.11	"
32.72	20.59	"	40.76	21.60	"
47.75	13.18	" + CO(NH ₂) ₂	44.45	19.24	"
47.31	12.78	CO(NH ₂) ₂	53.85	14.95	" + CO(NH ₂) ₂
45.40	8.02	"	54.57	12.34	CO(NH ₂) ₂
40.84	0.0	"	55.29	11.04	"
			46.92	0.0	"

1.4.2 = CaCl₂·4CO(NH₂)₂·2H₂O

1.4 = CaCl₂·4CO(NH₂)₂

THE SYSTEM CALCIUM CHLORIDE - URETHAN - WATER AT 25°
(Palitzsch, 1928, 1929)

Gm. Mols. per 1000 gms. H₂O

NH ₂ COOC ₂ H ₅	CaCl ₂	Solid Phase
0.0	7.305	CaCl ₂ ·6H ₂ O
0.3356	7.359	" + NH ₂ COOC ₂ H ₅
0.7004	5.949	NH ₂ COOC ₂ H ₅
11.093	4.482	"
53.09	0.0	"

The solubility of CaCl₂ in Glycine Solutions is reported by Joseph, C1 1935.

Distribution data for the system CaCl₂ + HCl + (C₂H₅)₂O + H₂O, which exists as three liquid layers, are given by Szaflka, 1942.

100 gms. of a mixture of equal volumes of Water and Ethyl Ether saturated with HCl at 0° will dissolve 0.49 gms. CaCl₂. (Fischer and Seidel, 1941).

EQUILIBRIUM IN THE SYSTEM CALCIUM CHLORIDE - DIOXANE - WATER AT 25°
(Bogardus and Lynch, 1943)

The solid phases were identified by wet residue analyses.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Two Liquid Layers:
CaCl ₂	Dioxane		CaCl ₂	Dioxane	
44.8	1.3	CaCl ₂ ·6H ₂ O	*128.6	27.9	Upper Layer
44.5	2.5	" + 1:1:2	{ 0.00	98.54	Lower Layer
43.9	3.7	1:1:2	{ 19.3	32.8	Upper Layer
41.6	7.3	"	{ 0.00	95.98	Lower Layer
39.8	10.0	"	{ 12.8	40.2	Upper Layer
39.1	11.1	"	{ 0.05	92.71	Lower Layer
36.5	15.0	"	{ 6.41	54.0	Upper Layer
33.8	19.7	"	{ 0.99	80.5	Lower Layer

1:1:2 = CaCl₂·(C₂H₄)₂O₂·2H₂O

*Two liquid phases in equilibrium with CaCl₂·(C₂H₄)₂O₂·2H₂O.

EQUILIBRIUM IN THE SYSTEM CALCIUM CHLORIDE - METHYL ETHYL KETONE -
WATER AT ROOM TEMPERATURE (23.5° - 26°)
(Meissner and Stokes, 1944)

Water was determined by difference in the water layer, and Methyl Ethyl Ketone by difference in the Ketone Layer.

Water Layer Wt. %			Ketone Layer Wt. %	
CH ₃ COC ₂ H ₅	CaCl ₂	H ₂ O	H ₂ O	CH ₃ COO ₂ H ₅
...	45.0	55.0	....	..
1.96	43.50	54.5	0.705	99.3
2.26	33.65	64.1	1.87	98.1

(Cont.)

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM CHLORIDE - METHYL ETHYL KETONE - WATER AT ROOM TEMPERATURE (23.5° - 26°)—Cont.

Water Layer Wt. %			Ketone Layer Wt. %	
CH ₃ COC ₂ H ₅	CaCl ₂	H ₂ O	H ₂ O	CH ₃ COC ₂ H ₅
3.42	26.10	70.5	4.11	95.9
5.11	20.35	74.5	5.22	94.8
10.6	10.40	79.0	7.61	92.4
16.8	4.12	79.1	12.00	88.0
22.4	0.0	77.6	12.60	87.4

Cl

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS ALCOHOL AT ROOM TEMPERATURE (Böttker, 1897)

Solution Used	Vol. Percent Alcohol	Gms. CaCl ₂ per 5 cc. Sol.
15 Gms. CaCl ₂ ·6H ₂ O + 20 cc. alcohol	92.3	1.430
15 Gms. CaCl ₂ ·6H ₂ O + 20 cc. alcohol	97.3	1.409
15 Gms. CaCl ₂ ·6H ₂ O + 20 cc. alcohol	99.3	1.429
15 Gms. CaCl ₂ ·6H ₂ O + 20 cc. alcohol + 1 Gm. CaCl ₂	99.3	1.529
15 Gms. CaCl ₂ ·6H ₂ O + 20 cc. alcohol + 2 Gms. CaCl ₂	99.3	1.561
" + 3 " "	99.3	1.590
" + 4 " "	99.3	1.641
" + 5 " "	99.3	1.709

SOLUBILITY OF CALCIUM CHLORIDE IN METHANOL AND ETHANOL

CALCIUM CHLORIDE ALCOHOLATES CaCl₂·3CH₃OH, CaCl₂·3C₂H₅OH

(The compounds were prepared by mixing anhydrous CaCl₂ with the alcohol. In the case of the methyl alcohol compound, the tri CH₃OH salt crystallizes above 55°, the tetra salt below this temperature.)

SOLUBILITY OF CaCl₂·3C₂H₅OH IN ETHANOL (SYNTHETIC METHOD) (Menschutkin, 1906)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
t°	CaCl ₂ ·3C ₂ H ₅ OH	= CaCl ₂	t°	CaCl ₂ ·3C ₂ H ₅ OH	= CaCl ₂
0	34.8	15.5	80	86.8	38.7
20	46	20.5	85	89.2	39.7
40	58.7	26.1	90	91.9	40.8
60	73	32.5	95	96.2	42.8
70	80.8	36	97°m.pt.	100	44.5

SOLUBILITY OF $\text{CaCl}_2 \cdot x\text{CH}_3\text{OH}$ IN METHANOL (SYNTHETIC METHOD)
(Menschutkin, 1906)

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
t°	$\text{CaCl}_2 \cdot 3\text{CH}_3\text{OH} = \text{CaCl}_2$		Phase	t°	$\text{CaCl}_2 \cdot 3\text{CH}_3\text{OH} = \text{CaCl}_2$		Phase
0	33.3	17.85	1:4	95	66.3	35.5	1:3
10	37.6	20.15	"	115	70.3	37.6	"
20	42.2	22.6	"	135	75.2	40.3	"
30	47	25.2	"	155	81.8	43.8	"
40	52	27.8	"	165	86.2	46.2	"
50	57.3	30.7	"	170	89.5	47.9	"
55	60	32.1	"	174	93.5	50.1	"
56	61.3	32.8	"	177m.pt.	100	53.6	"
55	60.5	32.4	" + 1:3	190	...	55.7	1:1 (?)
75	63.1	33.8	1:3	215	...	57.7	"

Cl

1:4 = $\text{CaCl}_2 \cdot 4\text{CH}_3\text{OH}$ 1:3 = $\text{CaCl}_2 \cdot 3\text{CH}_3\text{OH}$ 1:1 = $\text{CaCl}_2 \cdot \text{CH}_3\text{OH}$

SOLUBILITY OF CALCIUM CHLORIDE IN THE HIGHER ALCOHOLS
(Lloyd, Brown, Glynnwyn, Bonnel and Jones, 1928)

t°	Gms. CaCl_2 per 100 gms. of each alcohol				
	n Propyl	n Butyl	n Amyl	Iso Amyl	Benzyl
0	8.3	16.2	..	..	..
10	11.9	21.4	7.0	3.0	2.1
20	15.8	25.7	11.5	7.2	1.82
30	20.0	29.1	17.0	12.1	1.64
40	24.5	31.6	22.6	17.0	1.45
50	29.1	33.5	28.5	22.8	1.34
60	34.9	34.8	34.4	26.9	1.25
70	..	..	41.3	31.6	..

In each case the solid phase in contact with the saturated solution is the tri alcoholate of calcium chloride. These are respectively: n Propyl = $\text{CaCl}_2 \cdot 3\text{n-C}_3\text{H}_7\text{OH}$; n Butyl = $\text{CaCl}_2 \cdot 3\text{n-C}_4\text{H}_9\text{OH}$; n Amyl = $\text{CaCl}_2 \cdot 3\text{n-C}_5\text{H}_{11}\text{OH}$; iso Amyl = $\text{CaCl}_2 \cdot 3\text{iso-C}_5\text{H}_{11}\text{OH}$; Benzyl = $\text{CaCl}_2 \cdot 3\text{C}_6\text{H}_5\text{CH}_2\text{OH}$.

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ACETONE AT 20°
(Frankforter and Cohen, 1914)

Measured amounts of acetone were added to known solutions of CaCl_2 in water, until opalescence, indicative of the separation of a second liquid layer, was observed. The composition of a large number of such mixtures gives the limiting values for the binodal curve of the system. Tie lines were also determined in several instances by using such quantities of the three components that an adequate amount of each layer would be formed to permit the determination of the CaCl_2 in it. The

Ca CALCIUM

SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ACETONE
AT 20°--Cont.

points thus located on the curve fix the tie lines, and from them the approximate position of the plait point can be estimated.

Points on the Binodal Curve at 20°				Composition of Points Representing Tie Lines at 20°			
Gms. per 100 Gms. Sat. Sol.				Gms. per 100 Gms. Upper Layer		Gms. per 100 Gms. Lower Layer	
Acetone	CaCl ₂			Acetone	CaCl ₂	Acetone	CaCl ₂
Cl	9	40.5*	(solid phase CaCl ₂)	90.2	0.186	28.5	16.61
	22.7	38.16†		83.3	0.628	34.6	12.97
	20.8	31.2		81.0	0.948	40.0	10.60
	20.2	28.0		78.5	1.321	43.5	9.36
	21	24.4		60.0	5 (plait point)	60.0	5
	23	21.1					
	25	19.2					
	30	15.6					
	35	12.8					
	40	10.5					
	45	8.8					
	50	7.4					
	55	6.1					
	60	5.0		t°			
	65	3.9		5	31.09		15.52
	70	2.8		10	22.77		23.64
	75	1.8		15	31.09		15.52
	80	1.0		18	30.58		15.27
	85	0.5		25	21.44		22.25
	90	0.2		25	29.83		14.89
	95	0.1		30	20.99		21.79
				30	29.27		14.62
				35	21.14		20.91
				35	28.59		14.29
				40	19.83		20.58
				40	27.90		13.93

Points on the Binodal Curve at
Different Temperatures
Gms. per 100
gms. Sat. Sol.

*Point on solubility curve.

†Quadruple point.

Altaba, 1951 found 0.005 gms. CaCl₂·6H₂O to dissolve in 100 gms. acetone at 20°.

SOLUBILITY OF CALCIUM CHLORIDE IN ANHYDROUS ACETONE
(Bell, Rowlands, Bamford, Thomas and Jones, 1930)

t°	Gms. CaCl ₂ per 100 gms. C ₃ H ₆ O	Solid Phase	t°	Gms. CaCl ₂ per 100 gms. C ₃ H ₆ O	Solid Phase
0	0.0062	CaCl ₂ ·2C ₃ H ₆ O	30	0.0131	CaCl ₂ ·2C ₃ H ₆ O
10	0.0073	"	35	0.0154	"
15	0.0086	"	40	0.0173	"
20	0.0101	"	45	0.0190	"
25	0.0118	"	50	0.0213	"

SOLUBILITY OF CALCIUM CHLORIDE IN ACETIC ACID AT VARIOUS TEMPERATURES
(Determined by the synthetic method)

(Menachutkin, 1906)

t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	$\left. \begin{array}{l} \text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH} \\ \text{COOH} \end{array} \right\} = \text{CaCl}_2$		
16.2 m. pt.	0	0	CH ₃ COOH
15	18	5.7	"
14	27	8.5	"
13	34	10.7	"
11.1 Eutec.	42	13.3	" + 1.4
30	47.6	15.0	1.4
35	50	15.8	"
40	54.7	17.3	"
45	63	19.9	"
50	69.5	21.9	"
60	79.5	25.1	"
65	84.5	26.7	"
70	91.2	28.8	"
73 m. pt.	100	31.6	"

Cl

1.4 = $\text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH}$.

SOLUBILITY OF OTHER CALCIUM CHLORIDE - ACETIC ACID COMPLEXES
(Gerbault, 1946)

The compounds were prepared by the action of Acetyl Chloride on Calcium Hydroxide. Solubilities are in terms of Moles per Liter.
[Ac = $\text{CH}_3\text{CO}-$].

Compound	Solvent			
	Water	Ethyl Alcohol	Acetic Acid	Ethyl Ether
$\text{CaCl}_2 \cdot \text{AcOH}$	1.1	...	0.053	0.0035
$\text{CaCl} \cdot \text{AcO}$	0.034	0.066	0.082	....
$\text{CaCl} \cdot \text{AcO} \cdot \text{CaO}$	0.067	0.128	0.167	0.087

Ca CALCIUM

SOLUBILITY OF CALCIUM CHLORIDE IN ACETAMIDE AT VARIOUS TEMPERATURES
(Determined by the synthetic method)

(Menschutkin, 1908)

		Gms. per 100 Gms. Sat. Sol.		
t°		$\overbrace{\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2} = \text{CaCl}_2$		Solid Phase
Cl	82 m. pt.	0	0	CH_3CONH_2
	78	8.0	3.1	"
	74	15.4	5.9	"
	66	27.0	10.4	"
	54	39.2	15.1	"
	46 Eutec.	45.0	17.3	" + 1.6
	58	48.5	18.7	1.6
	62	54.5	21.0	"
	64 tr. pt.	62.1	23.9	1.6 + 1.3
	100	65.6	25.3	1.3
	150	70.5	27.1	"
	165	74.8	28.8	"
	175	80.6	31.0	"
	180	85.5	32.9	"
	184	90.5	34.8	"
	186 tr. pt.	94.5	36.4	" + $\text{CaCl}_2(?)$
	200	97.5	37.5	$\text{CaCl}_2(?)$
	210	100	38.5	"

1.6 = $\text{CaCl}_2 \cdot 6\text{CH}_3\text{CONH}_2$. 1.3 = $\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2$.

SOLUBILITY OF CALCIUM CHLORIDE IN SEVERAL SOLVENTS

Solvent	t°	Solubility (per 100 gms. solvent)		Author
Monoethanolamine	25	14.0 gms. CaCl_2	(Ishin and Kobe, 1941)	
Ethylene glycol	25	20.6 " "	(")	
95% Formic acid	19	43.1 " "	(Aschan, 1913)	
Pyridine	25	1.66 " "	(Muller, 1925)	
Furfural	25	0.01 " "	(Trimble, 1941)	
"	25	0.08 gms. $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	(")	
Hydrazine (liq.)	"Room"	16. " CaCl_2	(Welsh and Broderson, 1915)	
Selenium oxychloride	25	6.51 gms. CaCl_2	(Wise, 1923)	
Sulfur dioxide (liq.)	25	0.02 " "	(Watt, Jenkins and Robertson, 1950)	

Fusion-Point Data are given for the following mixtures of calcium chloride and other salts.

$\text{CaCl}_2 + \text{CaF}_2$ (1)(2)(18)	$\text{CaCl}_2 + \text{CaO}$ (3)	$\text{CaCl}_2 + \text{CaSO}_4$ (3)(29)
$\text{CaCl}_2 + \text{CaI}_2$ (1)	$\text{CaCl}_2 + \text{CaSiO}_3$ (4)	$\text{CaCl}_2 + \text{CaSO}_4 + \text{KCl} + \text{K}_2\text{SO}_4$ (15)

(Cont.)

Fusion-point data are given for the following mixtures of calcium chloride and other salts--Cont.

$\text{CaCl}_2 + \text{CdCl}_2$ (14)	$\text{CaCl}_2 + \text{KCl}$ (5)(3)(12)(13)(19)(21)(26)
$\text{CaCl}_2 + \text{CoCl}_2$ (14)	$\text{CaCl}_2 + \text{NaCl}$ (5)(3)(12)(13)(21)(22)
$\text{CaCl}_2 + \text{CeCl}_3 + \text{NaCl}$ (20)(24)	$\text{CaCl}_2 + \text{NaCl} + \text{KCl}$ (12)(13)
$\text{CaCl}_2 + \text{CsCl}$ (21)(22)	$\text{CaCl}_2 + \text{AgCl}$ (5)
$\text{CaCl}_2 + \text{CsCl} + \text{RbCl}$ (21)	$\text{CaCl}_2 + \text{SrCl}_2$ (6)(7)(3)(10)(26)
$\text{CaCl}_2 + \text{CsCl} + \text{NaCl}$ (22)	$\text{CaCl}_2 + \text{SrO}$ (3)
$\text{CaCl}_2 + \text{CeCl}_3$ (29)	$\text{CaCl}_2 + \text{TlCl}$ (9)
$\text{CaCl}_2 + \text{SrF}_2 \rightleftharpoons \text{CaF}_2 + \text{SrCl}_2$ (27)	$\text{CaCl}_2 + \text{SnCl}_2$ (5)
$\text{CaCl}_2 + 2\text{KF} \rightleftharpoons \text{CaF}_2 + 2\text{KCl}$ (30)	$\text{CaCl}_2 + \text{ZnCl}_2$ (5)
$\text{CaCl}_2 + 2\text{LiF} \rightleftharpoons \text{CaF}_2 + 2\text{LiCl}$ (16)	$\text{CaCl}_2 + \text{RbCl}$ (17)(21)
$\text{CaCl}_2 + \text{CuCl}$ (5)	$\text{CaCl}_2 + \text{RbCl} + \text{NaCl}$ (23)
$\text{CaCl}_2 + \text{FeCl}_2$ (14)	$\text{CaCl}_2 + \text{KCl} + \text{PbCl}_2$ (19)
$\text{CaCl}_2 + \text{PbCl}_2$ (5)(6)(7)(19)	$\text{CaCl}_2 + \text{KCl} + \text{MgCl}_2$ (25)
$\text{CaCl}_2 + \text{LiCl}$ (7)(8)(11)(16)(21)(29)	$\text{CaCl}_2 + \text{KCl} + \text{NaCl}$ at 10% MgCl_2
$\text{CaCl}_2 + \text{MgCl}_2$ (5)(6)(26)	(31)(32)
$\text{CaCl}_2 + \text{MnCl}_2$ (6)(7)(14)	$\text{CaCl}_2 + \text{ZrO}_2$ (in atmospheres of Cl_2
$\text{CaCl}_2 + \text{SrF}_2 \rightleftharpoons \text{CaF}_2 + \text{SrCl}_2$ (27)	and HCl) (33)
$\text{CaCl}_2 + 2\text{KF} \rightleftharpoons \text{CaF}_2 + 2\text{KCl}$ (30)	$\text{CaCl}_2 + 2\text{LiF} \rightleftharpoons \text{CaF}_2 + 2\text{LiCl}$ (16)

Cl

(1) = Ruff and Plato, 1903; (2) = Plato, 1907; (3) = Sackur, 1911-12; (4) = Karandeeff, 1910; (5) = Menge, 1911; (6) = Sandonnini, 1911; (7) = Sandonnini, 1913; (8) = Sandonnini, 1913; (9) = Korreng, 1914; (10) = Schaefer, 1914; (11) = Grube and Rudel, 1924; (12) = Scholich, 1920; (13) = Lautsberry and Page, 1920; (14) = Ferrari-Inganni, 1928; (15) = Janecke and Muhlhausen, W. 1936; (16) = Bukalova and Bergman, 1949; (17) = Gromakov, 1950; (18) = Bukalova and Bergman, 1951; (19) = Ugai, 1950; (20) = Nishihara, Shimizu and Katori, 1950; (21) = Dergunov and Bergman, 1950; (22) = Plyushchev, Shakhno and Pozhumkova, 1955; (23) = Plyushchev, Kovalev and Shakhno, 1955; (24) = Nishihara, Tsuda and Shimizu, 1952; (25) = Ivanov, 1953; (26) = Ivanov, 1953a; (27) = Bukalova and Bergman, 1952; (28) = Nishihara and Ando, 1949; (29) = Golubeva and Bergman, 1954; (30) = Krauze and Bergman, 1942; (31) = Ivanov, 1953b; (32) = Streletz and Desyatnikov, 1955; (33) = Belozerskii and Kucherenko, 1940.

Data for the cryoscopy of mannitol, boric acid and lithium meta-borate in $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ (M.P. 29.35°) are given by Maes, 1953.

C10 CALCIUM Hypo CHLORITE $\text{Ca}(\text{ClO})_2$

C10

EQUILIBRIUM IN THE SYSTEM CALCIUM HYPOCHLORITE,
CALCIUM OXIDE AND WATER AT 0°
(O'Connor, 1927)

d ₄ ²⁰ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₄ ²⁰ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CaO	$\text{Ca}(\text{ClO})_2$			CaO	$\text{Ca}(\text{ClO})_2$	
1.213	0.0	21.8	$\text{Ca}(\text{ClO})_2 \cdot 3\text{H}_2\text{O}$	1.142	0.077	15.1	1.3.3
1.203	0.106	21.2	1.2.2	1.123	0.093	13.0	"
1.188	0.106	19.8	"	1.104	0.093	11.1	"
1.189	0.113	19.2	"	1.093	0.091	9.9	"

(Cont.)

(Cont.)

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM HYPOCHLORITE,
CALCIUM OXIDE AND WATER AT 0°--Cont.

d ₄ ^o of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d ₄ ^o of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CaO	Ca(ClO) ₂			CaO	Ca(ClO) ₂	
1.172	0.105	17.7*	1.2.2	1.133	0.111	14.0*	variable
1.154	...	16.1*	"	1.122	...	12.7*	"
1.171	...	18.0	" + 1.3.3	1.103	0.114	11.0*	"
1.168	...	17.8	1.3.3	1.077	0.110	8.2	Ca(OH) ₂
1.161	...	16.9	"	1.053	0.105	5.7	"
				1.030	0.106	3.0	"

1.2.2 = Ca(ClO)₂·2CaO·2H₂O1.3.3 = Ca(ClO)₂·3CaO·3H₂O

* = unstable equilibrium

ClO CALCIUM CHLORATE Ca(ClO₃)₂SOLUBILITY OF CALCIUM CHLORATE IN WATER
(Jegorow, 1931)

t°	Gms. Ca(ClO ₃) ₂ per 100 gms. sat. sol.	Solid Phase
-1.0	4.67	Ice
-4.2	13.9	"
-9.1	23.2	"
-17.1	32.5	"
-32.9	42.0	"
-39.6	45.0	"
-41.0 (Eutec.)	45.5	" + Ca(ClO ₃) ₂ ·6H ₂ O
-37.5	46.0	Ca(ClO ₃) ₂ ·6H ₂ O
-30.2	48.0	"
-28.0	51.2	"
-26.8 tr. pt.	55.0	" + Ca(ClO ₃) ₂ ·4H ₂ O
-26.3	55.0	Ca(ClO ₃) ₂ ·4H ₂ O
-16.2	58.0	"
-12.3	60.0	"
-7.8 tr. pt.	62.7	" + Ca(ClO ₃) ₂ ·2H ₂ O
-5.0	63.0	Ca(ClO ₃) ₂ ·2H ₂ O
+18	64*	"
19.5	66.2	"
20	66.16†	"
25.0	66.05	"
73.5	76.3	"
76. tr. pt.	77.0	" + Ca(ClO ₃) ₂
93.0	78.0	Ca(ClO ₃) ₂
127.0	80.1	"
203.0	85.0	"

*Mylus and Funk, 1897; density 1.729

†Mazetti, 1929.

THE SYSTEM CALCIUM CHLORATE - POTASSIUM CHLORATE - WATER AT 20°
(Mazetti, 1929)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
KClO ₃	Ca(ClO ₃) ₂		KClO ₃	Ca(ClO ₃) ₂	
0.0	66.16	Ca(ClO ₃) ₂ ·2H ₂ O	2.45	28.60	KClO ₃
1.10	64.31	" + KClO ₃	2.97	11.15	"
2.40	47.52	KClO ₃	6.76	0.0	"
2.39	36.89	"			

CALCIUM PERCHLORATE Ca(ClO₄)₂

ClO

SOLUBILITY OF ANHYDROUS CALCIUM PERCHLORATE IN SEVERAL SOLVENTS AT 25°
(Willard and Smith, 1923)

Solvent	d of sat. sol.	Gms. Ca(ClO ₄) ₂ per 100 gms. sat. sol.
Water	1.7191	65.35
Methyl alcohol	1.6155	70.36
Ethyl "	1.4342	62.44
n Propyl "	1.3806	59.17
n Butyl "	1.2868	53.17
iso " "	1.0903	36.29
Acetone	1.1475	38.18
Ethyl acetate	1.3325	43.06
Ethyl ether	0.7098	0.26

Freezing point depressions in solutions of Ca(ClO₄)₂ from 0.001 to 1.0 molal are given by Nicholson and Felsing, 1950.

CALCIUM Hexa Antipyrine PERCHLORATE [Ca(COC₁₀H₁₂N₂)₆](ClO₄)₂

100 cc sat. solution in water ($d_{4}^{25} = 1.316$) contain 2.78 gm. Ca(COC₁₀H₁₂N₂)₆ (ClO₄)₂ at 20°. (Wilke-Dörfurt and Schliephake, 1929).

Ca CALCIUM

CrO CALCIUM CHROMATE CaCrO_4 SOLUBILITY OF THE SEVERAL HYDRATES IN WATER
(Mylius and Wrochem, 1900)

t°	Gms. CaCrO_4 per 100 Gms.		Mols. CaCrO_4 per 100 Mols. H_2O	t°	Gms. CaCrO_4 per 100 Gms.		Mols. CaCrO_4 per 100 Mols. H_2O
	Water	Solu- tion			Water	Solu- tion	
Solid Phase, $\text{CaCrO}_4 \cdot 2\text{H}_2\text{O}$ (Monoclinic)				Solid Phase, $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$			
0	17.3	14.75	2.0	0	7.3	6.8	0.84
18	16.68	14.3	1.93	18	4.8	4.4	0.51
20	16.6	14.22	1.93	31	3.84	3.7	0.44
30	16.5	13.89	1.85	38.5	2.67	2.6	0.31
45	14.3	12.53	1.65	50	1.63	1.6	0.19
Solid Phase, $\text{CaCrO}_4 \cdot 2\text{H}_2\text{O}$ (Rhombic)				60	1.13	1.1	0.13
0	10.9	9.8	1.25	100	0.81	0.8	0.09
18	11.5	10.3	1.33	Solid Phase, CaCrO_4			
40	11.6	10.4	1.34	0	4.5	4.3	0.52
Solid Phase, $\text{CaCrO}_4 \cdot \text{H}_2\text{O}$				18	2.32	2.27	0.27
0	13.0	11.5	1.50	31	2.92	1.89	0.22
18	10.6	9.6	1.22	50	1.12	1.11	0.13
25	10.0	9.1	1.15	60	0.83	0.82	0.11
40	8.5	7.8	0.98	70	0.80	0.79	0.09
60	6.1	5.7	0.70	100	0.42	0.42	0.05
75	4.8	4.6	0.56				
100	3.2	3.1	0.37				

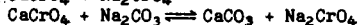
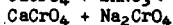
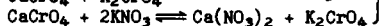
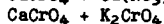
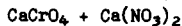
Densities of the saturated solutions of the above several hydrates at 18° are: $\text{CaCrO}_4 \cdot 2\text{H}_2\text{O}$, 1.149; $\beta\text{CaCrO}_4 \cdot 2\text{H}_2\text{O}$, 1.105; $\text{CaCrO}_4 \cdot \text{H}_2\text{O}$, 1.096; $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$, 1.044; CaCrO_4 , 1.023.

SOLUBILITY IN ALCOHOL
(Fresenius, 1891)

100 cc. 29% alcohol dissolve 1.206 grams CaCrO_4 .

100 cc. 53% alcohol dissolve 0.88 gram CaCrO_4 .

Melting point data are given for



Kitrov, 1949

Vilinyanskii and Pudovkina, 1948

Vilinyanskii and Pudovkina, 1948a

CALCIUM DICHROMATE

CrO

THE SYSTEM CALCIUM DICHROMATE - WATER
(Hartford, Lane and Meyer, 1950; Tarasenkova and Konopkina, 1954)

There is disagreement on the degree of hydration at each temperature.

t°	Gms. CaCr_2O_7 per 100 gms. sat. sol.			Solid Phase	t°	H.L. & M.			t°	T. & K.			Solid Phase
	H.L. & M.		T. & K.			Gms. CaCr_2O_7 per 100 gms. sat. sol.		Solid Phase		Gms. CaCr_2O_7 per 100 gms. sat. sol.		Solid Phase	
-0.4	...	5.09	I		-31.3	49.3	(I + 4.5)			...		....
-1.2	8.00	...	I		-40.0	...	...			52.50		(I + 6)	
-1.5	...	9.75	I		-12.2	50.29	(4.5)			...		....
-3.1	18.55	18.94	I		0	...	...			53.47		(6)	
-6.1	26.25	...	I		+0.4	53.01	(4.5)			...		....
-7.6	...	28.46	I		8.1	...	...			54.60		(6)	
-11.0	33.69	...	I		10	...	...			55.34		(6)	
-15.1	...	38.40	I		20	57.13	(4.5)			57.87		(5)	
-17.2	40.59	...	I		30	59.56	(4.5)			59.92		(5)	
-26.2	46.74	...	I		35	61.00	(4.5)			61.14		(5)	
-27.1	47.50	...	I		40	62.47	(4.5)			62.60		(5)	
-27.6	...	47.76	I		45	63.40	(3)			...		....
-27.8	...	47.80	I		50	64.21	(3)			64.35		(4)	
-29.9	48.90	...	I		60	65.74	(3)			65.54		(4)	
-35.4	...	50.80	I		70	...	...			66.37		(D)	
					80	...	...			68.32		(D)	
					90	...	...			70.60		(D)	
					100	...	...			72.70		(D)	

I = Ice. (6) = $\text{CaCr}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$. (5) = $\text{CaCr}_2\text{O}_7 \cdot 5\text{H}_2\text{O}$.
 (4.5) = $\text{CaCr}_2\text{O}_7 \cdot 4.5\text{H}_2\text{O}$. (4) = $\text{CaCr}_2\text{O}_7 \cdot 4\text{H}_2\text{O}$. (3) = $\text{CaCr}_2\text{O}_7 \cdot 3\text{H}_2\text{O}$
 (D) = Mixture of $\text{CaCr}_2\text{O}_7 \cdot \text{aq}$ + $\text{CaCrO}_4 \cdot \text{aq}$.

CALCIUM FLUORIDE CaF_2

F

SOLUBILITY OF CALCIUM FLUORIDE IN WATER

t°	Gms. CaF_2 per liter sat. sol.		Authority
0	0.013	(fluorspar)	Kohlrausch, 1904-05, 1908
15	0.015	(fluorspar)	"
18	0.016		"
18	0.018		Mougnard, 1931
18	0.015	(calcined)	"
25	0.018		Aumeras, 1927a
25	0.016	(fluorspar)	Kohlrausch, 1904-05, 1908
25	0.040	(pH = 6.4)	Carter, 1928
40	0.017	(fluorspar)	Kohlrausch, 1904-05, 1908)

Ca CALCIUM

SOLUBILITY OF CALCIUM FLUORIDE IN WATER--Cont.

Results of Booth and Bidwell, 1950 at High Temperatures:

t°	Gms. CaF ₂ per 100 gms. H ₂ O	t°	Gms. CaF ₂ per 100 gms. H ₂ O	t°	Gms. CaF ₂ per 100 gms. H ₂ O	t°	Gms. CaF ₂ per 100 gms. H ₂ O
179	0.0022	265	0.0021	346	0.0054	380	0.0007
194	.0022	275	.0017	360	.0062	384	.0034
199	.0018	290	.0024	361	.0045	388	.0009
214	.0016	308	.0029	363	.0020	391	.0009
238	.0021	328	.0037	367	.0024	400	.0009
F 262	.0025	330	.0030	367	.0028	421	.0015

SOLUBILITY OF CALCIUM FLUORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID
(Tananaew and Tchrelachwill, 1936)

The solutions were shaken 6-10 days in paraffined vessels. The calcium was determined by permanganate titration. Temp.?

Normality of aq. HCl	Gm. mols. CaF ₂ dissolved per liter	pH of sat. sol.
0.01	0.00087	2.02
0.10	0.0053	1.05
1.00	0.0280	0.04

Results for this system are also given by Aumeras, 1927a. Measured volumes of standard HF and CaCl₂ solutions were mixed and the resulting precipitate of CaF₂ caused to redissolve by successive additions of standard HCl, keeping the volume at 100 cc and temperature at 25°. The results are expressed in terms of normality of HF and HCl.

SOLUBILITY OF CALCIUM FLUORIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID
Results of Mougard, 1931 at 18°

Normality of CH ₃ COOH	0.083	0.166	0.333	0.833
Gms. CaF ₂ per 100 cc	0.00308	0.00383	0.00407	0.00498

Results of Duparc, Wengen and Graz, 1925 at higher temperatures

Gms. CaF ₂ dissolved per 100 cc. in aqueous			
t°	0.5 Normal CH ₃ COOH	1.0 Normal CH ₃ COOH	2.0 Normal CH ₃ COOH
40	0.0153	0.0175	0.0192
60	0.0178	0.0203	0.0229
80	0.0206	0.0237	0.0267
100	0.0229	0.0264	0.0300

SOLUBILITY OF CALCIUM FLUORIDE IN AQUEOUS SOLUTIONS OF AMMONIA
AND AMMONIUM SALTS AT 18°
(Mougnard, 1931)

Solvent	Normality	Gms. CaF_2 dissolved per liter	Solvent	Normality	Gms. CaF_2 dissolved per liter
NH_3	1.00	0.0176	$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	0.33	0.0203
NH_4Cl	1.66	0.0175	"	0.71	0.0219
"	0.25	0.0208	"	1.42	0.0245
"	0.50	0.0258	"	1.66	0.0255
"	1.00	0.0278			
"	1.66	0.0278			

F

SOLUBILITY OF CALCIUM FLUORIDE IN ANHYDROUS HF AND BF_3

in HF (Jache and Cady, 1952)		in BF_3 (Sheft, Hyman and Katz, 1953)	
The solid phase is apparently $\text{CaF}_2 \cdot 2\text{HF}$			
t°	Gms. CaF_2 per 100 gms. HF	t°	Gms. CaF_2 per 100 gms. sat. sol.
-23.0	1.444	25	0.033
-3.3	1.061	75	<0.002
+12.2	0.817		

Fusion point data are given for:

$\text{CaF}_2 + \text{CaI}$ - Ruff and Plato, 1903; McCreary, 1955
 $\text{CaF}_2 + \text{CaSiO}_3$ - Karandeef, 1910
 $\text{CaF}_2 + \text{MgF}_2$ - Fuseya, Mori and Imamura, 1933
 $\text{CaF}_2 + \text{MgF}_2 + \text{NaF}$ - Grube and Heune, 1930
 $\text{CaF}_2 + \text{NaF}$ - Fedotieff and Iljinsky, 1923; Silber and Ishaque, 1951
 $\text{CaF}_2 + \text{KF}$ - Silber and Ishaque, 1951; Ishaque, 1952
 $\text{CaF}_2 + \text{KF} + \text{NaF}$ - Silber and Ishaque, 1951
 $\text{CaF}_2 + \text{LiF}$ - Bergman and Bychkova, 1955
 $\text{CaF}_2 + \text{Li}_2\text{SiO}_3$ - Bergman and Bychkova, 1955
 $\text{CaF}_2 + \text{Li}_2\text{SiO}_3 \rightleftharpoons \text{CaSiO}_3 + 2\text{LiF}$ - Bergman and Bychkova, 1955
 $\text{CaF}_2 + \text{CaO}$ - Budnikov and Trevyatskii, 1953
 $\text{CaF}_2 + \text{MgO}$ - " " -1953a
 $\text{CaF}_2 + \text{Na}_2\text{CaSiO}_4$ - Brisi, 1950-51
 $\text{CaF}_2 + \text{SrF}_2$ - Bukalova and Bergman, 1952

Data for the cryoscopy of Li_2SO_4 , ZrO_2 , TiO_3 , Na_2WO_4 , Na_2MoO_4 and Na_2SiO_3 in the CaF_2 -NaF eutectic are given by Harrison, Petit and Plancel (1955). Similar data with NaCl, KCl, CaCl_2 , NaF, KF and CaF_2 are given by Ishaque (1952).

F CALCIUM Hexa Antipyrine FLUOBORATE $[\text{Ca}(\text{COC}_{10}\text{H}_{12}\text{N}_3)_6](\text{BF}_4)_2$

100 cc sat. solution in water ($d_{25} = 1.313$) contain 3.5 gm. $\text{Ca}(\text{COC}_{10}\text{H}_{12}\text{N}_3)_6 (\text{BF}_4)_2$ at 20°. (Wilke-Dörfurt and Mureck, 1929).

Ca · CALCIUM

CALCIUM FLUOSILICATE

100 cc sat. solution in water contain 10.58 gm. CaSiF_6 at 22°. A commercial sample of calcium silico fluoride dissolved only to the extent of 0.331 gms. per 100 cc sat. solution at 25°. A "calcium fluo-silicate compound," used as insecticide, dissolved only to the extent of 0.153 gm. per 100 cc at 25°. (Carter, 1930).

I CALCIUM IODIDE CaI_2

SOLUBILITY IN WATER

(Average curve from the results of Kremers, 1858 and Etard, 1894; recent results (below) are in agreement.)

t°	Gms. CaI_2 per 100 Gms. Solution	t°	Gms. CaI_2 per 100 Gms. Solution	t°	Gms. CaI_2 per 100 Gms. Solution
0	64.6	30	69	80	78
10	66.0	40	70.8	100	81
20	67.6	60	74		

Density of solution saturated at 20° = 2.125.

Freezing points of dilute CaI_2 solutions are given by Rakowsky and Garrett, 1954.

THE SYSTEM CALCIUM IODIDE - CALCIUM HYDROXIDE - WATER AT 25° (Millikan, 1917)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaO	CaI_2		CaO	CaI_2	
0.118	0.0	$\text{Ca}(\text{OH})_2$	0.054	46.37	1.3.16
0.076	9.14	"	0.055	47.09	"
0.089	17.42	"	0.047	49.70	"
0.087	25.80	"	0.139	59.34	"
0.097	25.44	" + 1.3.16	0.587	66.72	" + $\text{CaI}_2 \cdot 6\text{H}_2\text{O}$
0.089	31.33	1.3.16	0.553	66.65	" "
0.064	40.30	"	0.0	66.80	$\text{CaI}_2 \cdot 6\text{H}_2\text{O}$

1.3.16 = $\text{CaI}_2 \cdot 3\text{CaO} \cdot 16\text{H}_2\text{O}$

EQUILIBRIUM IN THE SYSTEM CALCIUM IODIDE - INDIUM IODIDE - WATER AT ROOM TEMPERATURE (Ensslin, Ziemeck, and Schaepdryver, 1947)

Gms. per 100 ml. Sat. Sol.		Solid Phase	Gms. per 100 ml. Sat. Sol.		Solid Phase
InI_3	CaI_2		InI_3	CaI_2	
124.3	69.7	$\text{CaI}_2 \cdot 2\text{InI}_3 \cdot 8\text{H}_2\text{O}$	3.8	117.9	$\text{CaI}_2 \cdot \text{InI}_3 \cdot 6\text{H}_2\text{O}$
22.5	107.1	"	3.2	124.7	CaI_2 aq.
10.9	112.2	$2\text{CaI}_2 \cdot 3\text{InI}_3 \cdot 13\text{H}_2\text{O}$	1.6	131.5	"

SOLUBILITY OF CALCIUM IODIDE IN METHYL ALCOHOL
(Lloyd, Broun, Glynwyn, Bonnell and Jones, 1928)

t°	Gms. CaI ₂ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. CaI ₂ per 100 gms. CH ₃ OH	Solid Phase
0	116.4	CaI ₂ .6CH ₃ OH	30	131.2	CaI ₂ .6CH ₃ OH
10	121.1	"	40	136.8	"
15	123.7	"	50	142.2	"
20	126.1	"	60	148.8	"

SOLUBILITY OF CALCIUM IODIDE IN ACETONE
(Bell, Rowlands, Bamford, Thomas and Jones, 1930)

t°	Gms. CaI ₂ per 100 gms. C ₃ H ₆ O	Solid Phase	t°	Gms. CaI ₂ per 100 gms. C ₃ H ₆ O	Solid Phase
0	72.6	CaI ₂ .3C ₃ H ₆ O	40	105.6	CaI ₂ .3C ₃ H ₆ O
10	80.5	"	50	112.9	"
20	88.8(88.34)*	"	60	119.6	"
30	97.2	"			

*Altaba (1951)

100 gms. sat. solution of Calcium Iodide in liquid ammonia contain 3.85 gms. CaI₂ at 0°. (Linhard and Stephan, 1933, 1934).

Fusion-point data for mixtures of CaI₂ + I₂ are given by Olivari, 1908.

CALCIUM Mercuric IODIDE CaI₂.HgI₂

A saturated solution of CaI₂ and HgI₂ in water at 15.9° was found by Duboin (1906) to have the composition CaI₂.1.3HgI₂.12.3H₂O; d = 2.89 and the solid phase in contact with the solution was CaI₂.HgI₂.8H₂O.

CALCIUM Periodide CaI₄(?)

Data for the formation of calcium periodide in aqueous solution at 25° are given by Herz and Bulla (1911). (See reference note under calcium perbromide).

CALCIUM IODATE Ca(IO₃)₂

10

SOLUBILITY OF CALCIUM IODATE IN WATER
(Hill and Broun, 1931)

The agreement with more recent investigators is excellent. The older work of Mylius and Funk (1897, 1900) is in error.

Ca CALCIUM

SOLUBILITY OF CALCIUM IODATE IN WATER--Cont.

t°	Gms. $\text{Ca}(\text{IO}_3)_2$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $\text{Ca}(\text{IO}_3)_2$ per 100 gms. sat. sol.	Solid Phase
0	0.0906a	$\text{Ca}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$	40	0.517	$\text{Ca}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$
5	0.119	"		(0.509)d	
15	0.195	"	50	0.590	"
18	0.222b	"	57.5	0.621	" + $\text{Ca}(\text{IO}_3)_2$
25	0.306	"	60	0.652*	$\text{Ca}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$
30	0.384	"	60	0.811*	"
35	0.476	" + $\text{Ca}(\text{IO}_3)_2 \cdot 4\text{H}_2\text{O}$	60	0.617	$\text{Ca}(\text{IO}_3)_2$
10 40	0.584*	$\text{Ca}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$	70	0.644	"
25	0.405*	$\text{Ca}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$	80	0.665	"
30	0.387c	"	90	0.668	"

aBell and Waind, 1950; Bell and George, 1953

bKilde, 1934; Pedersen, 1941

cKilde, 1934

dBell and George, 1953

*metastable

SOLUBILITY OF CALCIUM IODATE IN HYDROCHLORIC ACID SOLUTIONS
(Kilde, 1934)

Moles HCl per liter	18°	Moles $\text{Ca}(\text{IO}_3)_2$ per liter		30°
		18°	25°	
0.0	0.00569	0.00784	0.00991	
0.0998	.0094	.0126	.0154	
1.000	.0317	.0424	.0523	

Kilde, 1934 also gives results in HCl + NaCl solutions

SOLUBILITY OF CALCIUM IODATE IN SODIUM HYDROXIDE SOLUTIONS
(0°-Bell and Waind, 1950; 18, 25, 30°-Kilde, 1934)

Moles NaOH per liter	0°	Moles $\text{Ca}(\text{IO}_3)_2$ per liter		30°
		18°	25°	
0.0	0.002333	0.00569	0.00784	0.00991
0.010	....	.0062	.0084	.0110
.01816	.002836	...	...	...
.025	....	.0071	.0094	.0117
.03137	.003093	...	...	...
.04540	.003350	...	...	...
.050	....	.0080	.0105	.0129
.06810	.003606	...	...	...

Kilde, 1934 also gives results in NaOH + NaCl solutions.

SOLUBILITY OF CALCIUM IODATE IN CALCIUM HYDROXIDE SOLUTIONS

Results of Davies and Hoyle, 1951 at 25°

moles per liter		moles per liter		moles per liter	
Ca(OH)_2	$\text{Ca(IO}_3)_2$	Ca(OH)_2	$\text{Ca(IO}_3)_2$	Ca(OH)_2	$\text{Ca(IO}_3)_2$
0.0	0.00784	0.01028	0.00665	0.01513	0.00637
0.00363	.00727	.01286	.00648	.01860	.00623
.00429	.00719	.01426	.00642	.02093	.00615

Results of Kilde, 1934 at 18, 25, and 30°

		18°	25°	30°	10
moles per liter }	Ca(OH)_2 :	0.0108	0.0108	0.0108	
	$\text{Ca(IO}_3)_2$:	0.0045	0.0064	0.0086	

Kilde, 1934 also gives results in $\text{Ca(OH)}_2 + \text{NaCl}$ and $\text{Ca(OH)}_2 + \text{sugar}$ solutions at three temperatures.

SOLUBILITY OF CALCIUM IODATE IN AQUEOUS SOLUTIONS OF AMMONIA AT 25°

(Kolthoff and Stenger, 1934)

Conc. of NH_3 in mols. per liter	d_{25} of sat. sol.	Gm. mols. $\text{Ca(IO}_3)_2$ per liter	Gms. $\text{Ca(IO}_3)_2$ per 1000 gms. sat. sol.
0.0	0.999	0.00785	3.06
0.489	0.995	0.00779	3.05
0.986	0.991	0.00756	2.98
1.422	0.987	0.00733	2.89
1.966	0.983	0.00715	2.84

SOLUBILITY OF CALCIUM IODATE IN POTASSIUM HYDROXIDE SOLUTIONS

(Bell and George, 1953)

Results at 0° moles per liter		Results at 25° moles per liter		Results at 40° moles per liter	
KOH	$\text{Ca(IO}_3)_2$	KOH	$\text{Ca(IO}_3)_2$	KOH	$\text{Ca(IO}_3)_2$
0.0	0.002315	0.0	0.007838	0.0	0.01306
0.01380	.002716	0.00573	.008236	0.01577	.01448
.02292	.002919	.00695	.008318	.02717	.01546
.02932	.003058	.00807	.008389	.03234	.01570
.03836	.003183	.01070	.008565	.03677	.01618
.04424	.003309	.01464	.008765	.04975	.01702
.05424	.003436	.01784	.008943	.06525	.01784
.06827	.003709	.01959	.009059		
		.02238	.009245		
		.02708	.009504		
		.03586	.009907		
		.05429	.010718		

Ca CALCIUM

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF VARIOUS SALTS

Salt Solution	(Results of Kilde, 1934)		
KIO ₃	18°	25°	30°
Moles KIO ₃ per liter:	0.0167	0.0167	0.0167
Moles Ca(IO ₃) ₂ per liter:	0.00203	0.00375	0.00537

NaIO ₃	The System Ca(IO ₃) ₂ - NaIO ₃ - H ₂ O at 25° (Hill and Brown, 1931)		
10	Gms. per 100 gms. sat. sol.		
d ₂₅ of sat. sol.	NaIO ₃	Ca(IO ₃) ₂	Solid Phase
...	0.00	0.306	Ca(IO ₃) ₂ ·6H ₂ O
1.00	0.522	0.084	"
1.041	5.29	0.000	"
1.074	8.58	0.000	" + NaIO ₃ ·H ₂ O
...	8.58	0.000	NaIO ₃ ·H ₂ O

The mixtures were rotated for about two weeks.

Mg(IO ₃) ₂	(Results of Pedersen, 1941 at 17.9°)		
Mols. Mg(IO ₃) ₂ per 1000 ml. solvent	Gms. Mg(IO ₃) ₂ per 1000 ml. solvent	Mols. Ca(IO ₃) ₂ per 1000 ml. sat. sol.	Gms. Ca(IO ₃) ₂ per 1000 ml. sat. sol.
0.0	0.0	0.005686	2.217
.001009	.3775	.005087	1.984
.002011	.7524	.004528	1.766
.003012	1.127	.004029	1.571
.005000	1.871	.003174	1.238
.01000	3.742	.001771	0.6905

(Results of Chloupek, Danes and Dauesova, 1933 at 25°)

The solid phase in all cases was Ca(IO₃)₂·6H₂O.
The authors' table headings are "g/1000g H₂O" but it is evident
that gms. per 1000 gms. sat. solutions was intended.

		Gms. Ca(IO ₃) ₂ per 1000 gms. sat. solution in aq.			
KNO ₃ K ₂ SO ₄ (see also below)	Conc. of aq. salt solution in mols. per liter	KNO ₃	K ₂ SO ₄	MgSO ₄	MgCl ₂
MgSO ₄ (see also below)	0.0 (—H ₂ O)	3.03	3.03	3.03	3.03
	0.002	...	3.196	3.219	3.121
MgCl ₂ (see also below)	0.005	3.125	3.389	3.397	3.262
	0.01	3.207	3.666	3.663	3.444
	0.02	3.393	4.008	4.09	3.736
	0.05	3.695	5.077	4.952	4.331
	0.10	4.102	6.290	5.768	4.924
	0.20	4.677	...	...	...
	0.50	5.861	...	...	...

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF VARIOUS SALTS--Cont.

Salt
Solution

(Results of Kilde, 1934 at 18, 25, 30°)

MgCl ₂ (see also above)	Moles MgCl ₂ per liter	Moles Ca(IO ₃) ₂ per liter		
		18°	25°	30°
	0.0503	0.00841	0.0112	0.0138
	0.505	0.0153	0.0200	0.0243

MgSO₄(see also
above)

Results of Bell and George, 1953 at 0°, 25°, 40°

(These data at 25° are in agreement with those of Chloupek, Danes and Dausova (1933), above)

0°		25°		40°	
millimoles per 1000 gms. H ₂ O		millimoles per 1000 gms. H ₂ O		millimoles per 1000 gms. H ₂ O	
K ₂ SO ₄	Ca(IO ₃) ₂	K ₂ SO ₄	Ca(IO ₃) ₂	K ₂ SO ₄	Ca(IO ₃) ₂
3.33	2.620	3.41	8.439	3.05	13.74
5.85	2.821	5.14	8.744	5.96	14.38
9.67	3.026	8.16	9.184	8.88	14.91
12.78	3.192	10.70	9.552	11.83	15.48
15.75	3.328	12.59	9.772	14.09	15.81
20.53	3.471	15.08	10.077		
23.71	3.557	20.12	10.580		

10

MgSO₄(see also
above)

(Results of Wise and Davies, 1938 at 25°)

moles per liter sat. sol.			moles per liter sat. sol.		
MgSO ₄	Ca(IO ₃) ₂	Density	MgSO ₄	Ca(IO ₃) ₂	Density
0.00625	0.00904	1.001	0.01875	0.01042	1.004
.0125	.00979	1.002	.025	.01095	1.004

KCl

(see also
below)

(Results of Gross and Klinghoffer, 1930; Wise and Davies, 1938; Kilde, 1934 at 25°)

NaCl

(see also
below)Conc. of
aq. chloride
solution in
mols. per
literGm. Mols. Ca(IO₃)₂·6H₂O per liter sat. aq. solution of:

	KCl	NaCl	LiCl	NH ₄ Cl	CaCl ₂
LiCl					
NH ₄ Cl					
CaCl ₂					
(see also below)	0.0	0.007976	0.007976	0.007976	0.00784W. K.
	0.005	...	...	...	0.00681 K.
	0.00625	...	...	...	0.00669 W.
	0.01	...	...	...	0.00644 K.
	0.0125	0.00835 W.	0.00829 W.	...	...
	0.025	0.00873 W.	0.00868 W.	...	0.00544 W.
					(0.00557) K.
	0.05	0.009551	0.009677	0.009414	0.009732
		(0.00949) W.	(0.00929) W.		0.00490 W.
					(0.00491) K.
	0.0998	...	0.0105 K.	...	...
	0.10	0.01060	0.01052	0.01028	0.01068
		(0.01042) W.	(0.01023) W.		...
	0.15	0.01139	0.01123	0.01097	0.01149
	0.250	...	0.0123 K.	...	...
	0.30	0.01326	0.01303	0.01235	0.01344
	0.50	0.01516	0.01474	0.01371	0.01557
			(0.0146) K.		...
	0.75	0.01751	0.01648	0.01550	0.01775
					...

Ca CALCIUM

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF VARIOUS SALTS--Cont.

Salt Solution (Results of Gross and Klinghoffer, 1930; Wise and Davies, 1938; Kilde, 1934 at 25°)--Cont.

KCl, etc. Continued	Conc. of aq. chloride solution in mols. per liter	Gm. Mols. $\text{Ca}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$ per liter sat. aq. solution of:				
		KCl	NaCl	LiCl	NH_4Cl	CaCl_2
	1.00	0.01878	0.01867 (0.0179)K.	0.01720	0.01966	...
	1.50	0.02275	0.02115	0.01910	0.02292	...
	2.00	0.02559	0.02365	...	...	...

10

W. = Wise and Davies, 1938. Densities of KCl solutions (in order): 1.008, 1.0017, 1.0032, 1.0057; of NaCl solutions: 1.001, 1.0015, 1.0025, 1.0050; of CaCl_2 solutions: 1.0001, 1.0016, 1.0036
K. = Kilde, 1934.

KCl (see also above)	Data of Keefer, Rieber, and Bisson, 1940 at 25°			
	KCl per 1000 gms. H_2O		$\text{Ca}(\text{IO}_3)_2$ per 1000 gms. H_2O	
	moles	gms.	moles	gms.
	0.0	0.0	0.00786	3.065
	.02514	1.874	.00885	3.450
	.05036	3.754	.00970	3.782
	.1008	7.515	.01053	4.106

CaCl ₂ (see also above)		Results of Kilde, 1934 at 18°, 30°				
NaCl (see also above and below)	moles CaCl ₂ per liter	moles Ca(IO ₃) ₂ per liter		moles NaCl per liter	moles Ca(IO ₃) ₂ per liter	
		18°	30°		18°	30°
	0.005	0.00478	0.00865	0.0998	0.00777	0.0129
	0.010	0.00433	0.00822	0.250	0.00924	0.0150
	0.025	0.00375	0.00724	0.500	0.01105	0.0177
	0.050	0.00330	0.00658	1.000	0.0138	0.0216

NaCl (see also above)	Results of Bell and Waind, 1950 at 0°					
Moles NaCl per liter:	0.0	0.001	0.002	0.003	0.004	
Moles Ca(IO ₃) ₂ per liter:	0.002333	0.002371	0.002423	0.002459	0.002488	

Results of Wise and Davies, 1938 at 25°								
Na_2SO_4 $\text{K}_4\text{Fe}(\text{CN})_6$ $\text{NaC}_6\text{H}_7\text{O}_5$ (sodium mandelate)	Salt in aq. solvent	d_{25} of sat. sol.	Gm. mols. per liter		Salt in aq. solvent	d_{25} of sat. sol.	Gm. mole. per liter	
			Salt	$\text{Ca}(\text{IO}_3)_2$			Salt	$\text{Ca}(\text{IO}_3)_2$
$\text{K}_4\text{Fe}(\text{CN})_6$	1.0007	0.00125	0.00838	Na_2SO_4	1.001	0.00625	0.00890	
"	1.0013	0.0025	0.00884	"	1.002	0.0125	0.00975	
"	1.0018	0.00375	0.00943	"	1.003	0.01875	0.01045	
"	1.0023	0.0050	0.00980	"	1.004	0.025	0.01105	
				$\text{C}_6\text{H}_7\text{O}_5\text{Na}^*$	1.0002	0.020	0.00918	
				"	1.0047	0.050	0.01069	
				"	1.0090	0.100	0.01283	

*sodium mandelate, $\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{COONa}$

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF VARIOUS SALTS--Cont.

Salt Solution	Results of Davies and Wyatt, 1949 at 25°			
	Moles per liter		Moles per liter	
Na ₂ S ₂ O ₃	Na ₂ S ₂ O ₃	Ca(IO ₃) ₂	Na ₂ S ₂ O ₃	Ca(IO ₃) ₂
	0.0	0.007840	0.011566	0.009367
	0.007735	0.008907	0.014148	0.009613
	0.010853	0.009303	0.015430	0.009749

		Results of Kilde, 1936			
Ca(C ₃ H ₅ O ₃) ₂ (calcium lactate):		Gm. mols. Ca(IO ₃) ₂ dissolved per liter sat. sol. at:			10
NaC ₃ H ₅ O ₃ (sodium lactate)	Conc. of aq. salt solution in gm. mols. per liter	18°	25°	30°	
	0.00496 Ca(C ₃ H ₅ O ₃) ₂	0.00499	0.00715	0.00914	
	0.00992 "	0.00464	0.00677	0.00874	
	0.0198 "	0.00429	0.00633	0.00830	
	0.0496 "	0.00398	0.00593	0.00784	
	0.0992 "	0.00392	0.00585	0.00775	
	0.0100 NaC ₃ H ₅ O ₃	0.00631	0.00853	0.01058	
	0.0200 "	0.00693	0.00918	0.01131	
	0.0400 "	0.00781	0.01032	0.1274	
	0.1000 "	0.01003	0.01315	0.1609	
	0.200 "	0.01329	0.01689	0.02042	
	0.400 "	0.01781	0.02287	0.02756	

Na salts of organic acids	Results of Davies, 1938 at 25°		
	Sodium salt	Gm. mols. Na Salt per liter aq. solvent	Gm. mols. Ca(IO ₃) ₂ per liter sat. solution
	Na Glycollate	0.020	0.009315
	"	0.040	0.01056
	Na Methoxyacetate	0.020	0.00885
	"	0.040	0.009664
	Na Pyruvate	0.020	0.008837
	"	0.040	0.009609
	Na Aminocetate	0.020 (1)	0.009113
	"	0.040 (1)	0.01001
	Na β Hydroxy butyrate	0.0215	0.00879
	"	0.0430	0.00947
	Na Salicylate	0.020	0.008652
	"	0.040	0.009241
	Na Cyanoacetate	0.020	0.008652
	"	0.040	0.009241

(1) This solution also contained Ca(OH)₂.

Na salts of amino acids	Results of Davies and Waind, 1950 at 25°							
	Mmol. per liter		Mmol. per liter		Mmol. per liter		Mmol. per liter	
	Na Salt Ca(IO ₃) ₂		Na Salt Ca(IO ₃) ₂		Na Salt Ca(IO ₃) ₂		Na Salt Ca(IO ₃) ₂	
	Na aminoacetate		Na α-amino- propionate		Na salt of glycyl-glycinate		Monosodium glutamate	
	0.0	7.84	19.62	8.96	11.55	8.51	22.22	8.87
	28.35	9.55	21.08	8.99	13.06	8.56	23.00	9.06
	56.70	10.81	31.63	9.45	23.10	9.04	44.50	9.86
	74.70	11.40	42.17	9.85	34.85	9.55	46.47	9.92
	14.94	13.77	52.72	10.24	48.52	10.05	90.26	11.05
			63.27	10.61			92.85	11.14

Ca CALCIUM

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF VARIOUS SALTS--Cont.

Results of Davies and Waind, 1950 at 25°--Cont.

Salt Solution	Mmol. per liter		Mmol. per liter		Mmol. per liter		Mmol. per liter	
Na salts of amino acids--continued	Na Salt $\text{Ca}(\text{IO}_3)_2$		Na Salt $\text{Ca}(\text{IO}_3)_2$		Na Salt $\text{Ca}(\text{IO}_3)_2$		Na Salt $\text{Ca}(\text{IO}_3)_2$	
	Na salt of serine		Na α -Amino-propionate		Na hippurate		Disodium glutamate	
	11.22	8.62	73.80	10.92	24.15	8.76	5.62	8.68
	21.10	9.20	84.35	11.26	25.14	8.81	11.42	9.34
	56.10	10.68	98.64	11.58	48.36	9.45	21.43	10.42
			109.6	11.70	50.22	9.48	22.49	10.44
	Na salt of tyrosine		Na salt of di-iodotyrosine		Na salt of leucylglycine		Na salt of alanyl-glycine	
	19.09	9.02						
	32.20	9.69						
	35.89	9.98	18.64	9.17	52.55	9.61	61.22	9.83
			41.89	10.44				

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF AMINO ACIDS AT 25°
(Keefer, Rieber and Bisson, 1940; Monk, 1951)

Monk also gives data in glycine solutions containing KCl , CaCl_2 and KIO_3 .

K.R.&B. moles per 1000 gms. H_2O		M. moles per liter		K.R.&B. moles per 1000 gms. H_2O		M. moles per liter	
Glycine	$\text{Ca}(\text{IO}_3)_2$	Glycine	$\text{Ca}(\text{IO}_3)_2$	Alanine	$\text{Ca}(\text{IO}_3)_2$	Alanine	$\text{Ca}(\text{IO}_3)_2$
0.0	0.00786	0.0	0.00784	0.0251	0.00800	...	...
0.0251	.00806	...	...	.0503	.00814	...	...
.0503	.00823	.0503	.00820	...	...	0.0683	0.00821
.0755	.00849	...	...	.0755	.00829	...	...
.1008	.00865	.1009	.00858	...	...	...	.00838
.2009	.00951	.2009	.00932	.1008	.00845	...	...
.4055	.01111	...	...	...	...	.1963	.00886
.6140	.01297	...	...		
.8261	.01495	...	...		

Effect of KCl on the solubility of $\text{Ca}(\text{IO}_3)_2$ in glycine solutions at 25°. (See also Monk, 1951)

(Keefer, Rieber and Bisson, 1940)

The data are given in moles $\text{Ca}(\text{IO}_3)_2$ per 1000 gms. H_2O .

Moles KCl per 1000 gms. H_2O	moles glycine per 1000 gms. H_2O			
	0.0251	0.0503	0.0755	0.1008
0.0252	0.00899	0.00920	0.00939	0.00959
.0504	.00970	.00990	.01006	.01027
.1010	.01073	.01093	.01115	....

SOLUBILITY OF CALCIUM IODATE IN SOLUTIONS OF AMINO ACIDS AT 25°--Cont.

In Glycylglycine solutions (Monk, 1951) at 25°

Moles Glycylglycine per liter	0.03440	0.06517	0.08253	0.09126
" Ca(IO ₃) ₂	0.00823	0.00862	0.00888	0.00898

SOLUBILITY OF CALCIUM IODATE IN UREA AND DIOXANE SOLUTIONS
(Pedersen, 1941)

(for further data in dioxane solutions see table following)

In aq. Urea at 17.9°		In aq. Dioxane at 18.0°		10
Moles Urea per 1000 ml. Solvent	Moles Ca(IO ₃) ₂ per 1000 ml. Sat. Sol.	Moles Dioxane per 1000 ml. Solvent	Moles Ca(IO ₃) ₂ per 1000 ml. Sat. Sol.	
0.0	0.005686	0.0	0.005702	
0.100	.005821	.125	.005423	
.200	.005957	.250	.005159	
.400	.006233	.375	.004904	
.600	.006512	.500	.006452	
.800	.006805	.750	.004194	
1.000	.007103	1.000	.003771	
2.000	.008689			
4.000	.01258			
6.000	.01767			
8.000	.02496			

SOLUBILITY OF CALCIUM IODATE IN AQUEOUS SOLUTIONS OF
ORGANIC SOLVENTS AT 25°
(Monk, 1951b)

Solvent	Wt. %	Dielectric constant	Mmol. Ca(IO ₃) ₂ per liter sat. sol.	Solvent	Wt. %	Dielectric constant	Mmol. Ca(IO ₃) ₂ per liter sat. sol.
Water	100	78.5	7.84	Ethyl-	3.8	75.6	6.26
Methanol	4.72	76.5	4.88	acetate	6.1	73.8	5.50
	9.53	74.3	4.02	Dioxane*	2.2	76.6	7.04
	14.43	72.1	2.94		4.7	74.4	6.26
Ethanol	3.82	76.4	5.83		9.4	70.2	4.93
	7.67	74.1	4.33	Glycol	5.62	76.9	7.16
	11.59	72.1	3.23		11.24	75.3	6.60
Acetone	4.09	76.3	5.91		16.85	73.7	6.12
	8.25	73.9	4.46	Glycerol	6.31	76.6	7.75
	12.46	71.7	3.32		12.44	74.8	7.70
n-Propanol	4.16	75.8	5.72		18.43	73.9	7.70
	8.40	72.9	4.20				
	12.71	70.0	3.07				

*See table above for further data in dioxane solutions.

Ca CALCIUM

MnO CALCIUM PERMANGANATE $\text{Ca}(\text{MnO}_4)_2$

Bellinger, Friedman, et al. (1946) determined the freezing points of aqueous solutions of Calcium Permanganate. Their material analyzed 51.9% total MnO_4^- , of which about 1% was NaMnO_4 . The purity was 76.5% when the total MnO_4^- was calculated as $\text{Ca}(\text{MnO}_4)_2 \cdot 2\text{H}_2\text{O}$.

MnO_4^-	Freezing Point	MnO_4^-	Freezing Point
5	-1°	42	-37°
15	-4.5°	45	-53°
25	-10°	52	-49°
35	-22°		

MoO CALCIUM MOLYBDATE CaMoO_4

SOLUBILITY IN WATER (Spitsyn and Savich, 1952)

Two sharp breaks occur in the curve which may mean changes of solid phase.

t°	Gravimetric method mg CaMoO_4 per 100 gms. sat. sol.	Colorimetric method mg CaMoO_4 per 100 ml. sat. sol.	t°	Gravimetric method mg CaMoO_4 per 100 gms. sat. sol.	Colorimetric method mg CaMoO_4 per 100 ml. sat. sol.
0	0.0022	0.0019	75	0.0098	0.0095
22	.0025	.0022	80	.0109	.0112
50	.0027	.0025	90	.0087	.0095
65	.0049	...	100	.0085	.0090

Rao, 1954 gives the K_{sp} of CaMoO_4 as 1.24×10^{-5} (temp. not given) which is considerably greater than that calculated from the results above.

N CALCIUM AZIDE $\text{Ca}(\text{N}_3)_2$

100 gms. sat. solution of Calcium Azide in Water contain 27.6 gm. $\text{Ca}(\text{N}_3)_2$ at 0° and 31.0 gms. at 15.2°. (Curtius and Rissom, 1898).

CALCIUM NITRITE $\text{Ca}(\text{NO}_2)_2$

NO

SOLUBILITY IN WATER

Results of Bureau, 1935, 1937 The figures in parentheses show the densities of the saturated solutions			Results of Oswald, 1914		
t°	Gms. $\text{Ca}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $\text{Ca}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase
-3.75	10.0	Ice	-4	16.7	Ice
-9.05	19.85	"	-9.3	25.5	"
-13.0	25.6	"	-12.5	29.5	"
-16.8	30.0	"	-14.5	32.0	"
-20.0 (Eutec.)	34.2	" + $\text{Ca}(\text{NO}_2)_2 \cdot 4\text{H}_2\text{O}$	-17.5 (Eu.)	35.0	" + $\text{Ca}(\text{NO}_2)_2 \cdot 4\text{H}_2\text{O}$
-15	35.4	$\text{Ca}(\text{NO}_2)_2 \cdot 4\text{H}_2\text{O}$	-9.5	36.2	$\text{Ca}(\text{NO}_2)_2 \cdot 4\text{H}_2\text{O}$
0 (1.362)	39.01	"	0	38.3	"
+2.8	40.4	"	+16	42.3	"
14.0	44.85	"		($d_{16}=1.4205$)	"
18.0 (1.427)	45.8	"	18.5	43.0	"
28	50.7	"	42	51.8	"
34.6 (tr. pt.)	55.05	" + $\text{Ca}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	44	53.5	" + $\text{Ca}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$
56.8 (1.535)	56.25	$\text{Ca}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	54	55.2	$\text{Ca}(\text{NO}_2)_2 \cdot 2\text{H}_2\text{O}$
58.0	57.15	"	64	58.4	"
64.7 (1.560)	57.78	"	70	60.3	"
79.5 (1.577)	60.2	"	73	61.5	"
90.8	62.5	"	91	71.2	"
99.5 (1.651)	64.1	"			
115.	65.7	"			
125. (tr. pt.)	71.0	" + $\text{Ca}(\text{NO}_2)_2$			
129	86.4	$\text{Ca}(\text{NO}_2)_2$			

An aqueous solution simultaneously saturated with calcium nitrite and silver nitrite, contains 92.4 gms. $\text{Ca}(\text{NO}_2)_2$ + 11.2 gms. AgNO_2 per 100 gms. H_2O at 14° . (Oswald, 1914).

100 cc. sat. solution of calcium nitrite in 90% alcohol contain 39 gms. $\text{Ca}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ at 20° .

100 cc. sat. solution of calcium nitrite in absolute alcohol contain 1.1 gms. $\text{Ca}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ at 20° . (Vogel, 1903).

CALCIUM NITRATE $\text{Ca}(\text{NO}_3)_2$

NO

THE SYSTEM $\text{Ca}(\text{NO}_3)_2 - \text{H}_2\text{O}$

(Bassett and Taylor, 1912; Taylor and Henderson, 1915;
Sievarts and Petzold, 1933; Ewing, Krey, Law and Lang, 1927)

$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ is stable from the eutectic to its congruent melting point (42.7°). A wholly metastable β form of the tetrahydrate has been studied above 30° . $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ is stable from about 42.7° , through its congruent melting point (51.1°), until the dihydrate forms ($48-50^\circ$). $\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$ is then stable only up to $51-54^\circ$, whence the anhydrous salt saturates the solution.

Ca **CALCIUM**

THE SYSTEM $\text{Ca}(\text{NO}_3)_2 - \text{H}_2\text{O}$ --Cont.

	Gms. Ca(NO ₃) ₂ per 100 gms. sat. sol.	t°	Gms. Ce(NO ₃) ₂ per 100 gms. sat. sol.	t°	Results differing somewhat from those at left
	Solid Phase Ice		Solid Phase Ca(NO ₃) ₂ .4H ₂ O		(Data of Sieverts and Taylor, 1912)
-0.4	1.4	30	61.57*		Gms. Ca(NO ₃) ₂ per 100 gms.
-1.4	4.78	34	63.66*		t° sat. sol.
-1.9	6.53	38	66.56*		Solid Phase
-3.05	10.00	39	67.93*		Ca(NO ₃) ₂ .4H ₂ O
-4.15	12.98	39.6(m. pt.)	69.50*		40 65.3
-15.7	33.13	39	75.34*		42 67.3
-21.7	38.7				42.75 69.3
-28.7(Eutec.)	42.7	Solid Phase Ca(NO ₃) ₂ .3H ₂ O			Solid Phase
		40	70.37*		Ca(NO ₃) ₂ .3H ₂ O
NO Solid Phase Ca(NO ₃) ₂ .4H ₂ O		42.5	70.8e		42 65.3
-28.7	42.7(Eutectic)	45	71.45		42.75 69.3
-20.7	43.37	50	73.79		Solid Phase
-10	47.31	51	74.73		Ca(NO ₃) ₂ .3H ₂ O
0	50.50	51.1(m. pt.)	75.3		42.75 69.3
5	51.97	49	77.49b		44 69.6
10	53.55				46 70.6
15	54.94	Solid Phase Ca(NO ₃) ₂ .2H ₂ O			48 71.5
20	56.39	49	77.49b		50 83.0
25	57.98	51	78.05c		(Data of Ewing, Krey, Law and Lang, 1927)
30	60.41				Solid Phase
35	62.88	25	77.30*		Ca(NO ₃) ₂ .2H ₂ O
40	66.22	55	78.16		39.6 74.5a*
42	68.7	80	78.2		48.1 76.0*
47.7(m. pt.)	69.50	100	78.43		49.8 76.7*
42.5	71.3*	125	78.57		
42.2	71.8*	147.5	78.8		
40.9	73.4*	151	79		
39.6	74.5a*				
36.4	76.3*				
35.6	76.7*				
32.7	78d*				
a - Solid Phase Ca(NO ₃) ₂ .4H ₂ O + Ca(NO ₃) ₂ .2H ₂ O				*Metastable	
b " " Ca(NO ₃) ₂ .3H ₂ O + Ca(NO ₃) ₂ .2H ₂ O					
c " " Ca(NO ₃) ₂ .2H ₂ O + Ca(NO ₃) ₂					
d " " Ca(NO ₃) ₂ .4H ₂ O + Ca(NO ₃) ₂					
e " " Ca(NO ₃) ₂ .4H ₂ O + Ca(NO ₃) ₂ .3H ₂ O					

SOLUBILITY OF CALCIUM NITRATE IN NITRIC ACID SOLUTIONS

Results at 0°

(Flatt, Brunisholz and Fell, 1954)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
$\text{Ca}(\text{NO}_3)_2$	HNO_3	Solid Phase	$\text{Ca}(\text{NO}_3)_2$	HNO_3	Solid Phase
49.6	0.0	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	7.6	62.2	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O} +$ $\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$
29.1	19.5	"			
13.4	39.4	"	9.1	62.2	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ (metastable)
9.6	46.6	"			
7.3	50.9	"	6.4	64.2	$\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$
6.9	61.0	"	6.5	64.3	"
7.4	62.1	"	4.5	68.2	"
			2.5	75.4	" + $\text{Ca}(\text{NO}_3)_2$

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM NITRATE IN NITRIC ACID SOLUTIONS—Cont.

Results at 20°
(Flatt and Fritz, 1950)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Ca}(\text{NO}_3)_2$	HNO_3		$\text{Ca}(\text{NO}_3)_2$	HNO_3	
55.54	0.0	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	24.41	43.56	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
32.02	25.78	"	24.70	43.49	$\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
22.63	42.59	"			

NO

Results at 25°

Data of Bassett and Taylor, 1912				Data of Flatt and Fritz, 1950			
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
$\text{Ca}(\text{NO}_3)_2$	HNO_3	$\text{Ca}(\text{NO}_3)_2$	HNO_3	$\text{Ca}(\text{NO}_3)_2$	HNO_3	$\text{Ca}(\text{NO}_3)_2$	HNO_3
Solid Phase		Solid Phase		Solid Phase		Solid Phase	
$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$		$\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$		$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$		$\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$	
57.98	0	31.09	40.56	57.40	0.0	26.83b	44.55
54.82	3.33	26.07	45.70	46.61	11.63	23.08	48.70
52.96	5.87	17.41	55.48	38.70	21.30	15.63	57.46
51.58	7.21	12.25	62.05	38.44	21.72	10.23c	64.80
47.82	11.27	9.34	65.69	31.93	34.33	Solid Phase	
45.59	13.71	8.52	67.20	35.02a	33.13	$\text{Ca}(\text{NO}_3)_2$	
40.70	19.65	Solid Phase		42.89*	28.07	2.97	74.39
38.17	22.80	$\text{Ca}(\text{NO}_3)_2$		Solid Phase		0.09	86.39
34.46	28.81	5.06	71.12	$\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$		0.01	99.99
32.84	32.63	2.53	74.77	34.27	33.94		
32.50	33.52	1.05	78.56	34.39	33.82		
Solid Phase		0.54	80.83	29.82	39.69		
$\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$		0.36	85.83	27.26*	46.19		
33.44	35.63	0.01	90.90				
29.05	41.66	0	96.86				
27.70	45.70						

*metastable aSolid Phase $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ bSolid Phase $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$ cSolid Phase $\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2$

Results at 50°

According to Belopolsky and Urusov, 1937, $\text{Ca}(\text{NO}_3)_2$, $\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$, and $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ are all stable phases in the system and the area of saturated with respect to $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ is isolated from the other two saturation areas. (This occurs because $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ melts congruently at 51.1° , and in the system $\text{Ca}(\text{NO}_3)_2$ - H_2O , the invariant points saturated with $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$ and $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} + \text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ are at 49° and 40° respectively.)

Flatt, Brunisholz and Devereaz, 1956 report data which is generally similar, except that they found the saturation areas of $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ and $\text{Ca}(\text{NO}_3)_2$ to intersect.

Ca CALCIUM

SOLUBILITY OF CALCIUM NITRATE IN NITRIC ACID SOLUTIONS--Cont.

Results at 50°--Cont.

Data of Belopolsky and Uruaov, 1937 Data of Flatt, Bruniaholtz & Devereaz, 1956

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(NO ₃) ₂	HNO ₃		Ca(NO ₃) ₂	HNO ₃	
NO	*77.9	0.0	Ca(NO ₃) ₂ ·2H ₂ O	73.2	1.61	Ca(NO ₃) ₂ ·3H ₂ O
	75.93	1.46	" + Ca(NO ₃) ₂	73.9	1.52	"
	73.90	4.19	Ca(NO ₃) ₂	73.8	1.87	"
	72.25	5.91	"	74.4	1.64	"
	67.65	9.83	"	75.7	0.89	"
	59.03	17.26	"	75.8	0.59	" + Ca(NO ₃) ₂
	49.61	25.91	"	75.8	1.19	Ca(NO ₃) ₂
	26.37	48.89	"	73.7	2.98	"
	12.13	64.79	"	68.4	7.51	"
	3.49	75.77	"	63.4	12.32	"
	1.90	78.76	"	56.3	19.20	"
	0.0	97.57	"	51.5	23.85	"
	*76.82	0.0	Ca(NO ₃) ₂ ·3H ₂ O	51.1	23.85	"
	76.45	0.74	"	44.6	30.35	"
	74.91	0.92	"	44.4	30.8	"
	74.3	0.5	"	44.0	30.9	"
	74.07	0.0	"	32.1	42.7	"
				17.7	57.6	"
				3.1	76.4	"

*Bassett and Taylor, 1912

THE SYSTEM CALCIUM NITRATE - CALCIUM PHOSPHATE - WATER



(Belopolsky, Serebrennikova, and Shpunt, 1937, 1937a)

Grams per 100 gms. of Saturated Solution				Density	Solid	Grams per 100 gms. of Saturated Solution			Density	Solid
P ₂ O ₅	CaO	N ₂ O ₅	P ₂ O ₅			CaO	N ₂ O ₅			
Results at 25°										
24.20	5.81	0.0	...	A + B	3.79	18.75	35.47	1.576	A + C	
23.00	6.10	1.46	1.280	"	4.45	18.53	34.60	1.542	"	
21.20	6.53	3.17	1.298	"	5.54	18.23	34.69	1.568	"	
17.07	8.06	7.45	1.291	"	8.10	17.42	32.60	1.563	"	
14.60	8.72	10.18	1.320	"	9.92	16.85	32.30	1.579	"	
12.51	9.58	12.77	1.328	"	10.84	16.14	31.90	1.571	"	
10.45	10.52	16.06	1.341	"	12.01	16.29	30.92	...	"	
8.19	11.86	20.60	1.366	"	12.62	15.80	30.94	1.577	"	
7.69	12.08	19.00	1.370	"	15.69	14.70	29.76	...	"	
5.65	13.37	22.80	1.392	"	17.79	14.27	29.86	...	"	
4.96	13.95	24.27	1.408	"	18.21	14.24	30.36	1.572	A + C + E	
3.55	15.37	27.46	1.446	"	21.49	12.82	30.76	...	A + E	
2.02	17.57	31.71	1.486	"	23.94	11.79	30.43	...	"	
1.25	18.70	34.87	1.539	"	26.74	10.82	30.70	...	"	
1.18	19.73	37.26	1.551	A + B + C	29.90	9.76	29.83	...	"	
0.97	19.68	37.60	1.551	B + C	34.63	7.78	26.89	1.637	"	
0.36	19.66	37.58	1.558	"	35.62	7.27	25.32	1.656	"	
...	19.79	38.20	1.563	D + B + C	37.05	6.81	25.62	1.670	"	
2.05	19.25	36.21	1.552	A + C	39.25	5.70	23.08	1.679	"	

(Cont.)

THE SYSTEM CALCIUM NITRATE - CALCIUM PHOSPHATE - WATER--Cont. "
 $(\text{CaO} + \text{N}_2\text{O}_5 + \text{P}_2\text{O}_5 + \text{H}_2\text{O})$ --Cont.

Grams per 100 gms. of Saturated Solution				Solid	Grams per 100 gms. of Saturated Solution				Solid
P_2O_5	CaO	N_2O_5	Density		P_2O_5	CaO	N_2O_5	Density	
Results at 25° (Con.)					Results at 25° (Con.)				
41.70	4.99	21.52	1.634	A + E	17.92	0.58	52.40	1.509	F + G
44.56	4.23	19.34	1.592	"	23.34	0.35	48.89	1.541	"
0.0	11.03	51.89	1.536	C + E	28.51	0.23	44.77	1.564	"
2.84	12.29	49.94	1.559	"	30.65	0.0	42.65	1.560	"
3.98	12.10	49.03	...	"					
4.54	12.78	47.70	1.566	"	Results at 50°				
6.04	12.91	47.86	...	"	28.85	5.88	0.0	1.314	A + B NO
7.68	13.57	46.05	1.588	"	24.71	6.82	4.24	...	"
7.74	13.49	44.44	1.586	"	20.62	8.15	8.32	1.326	"
9.31	14.34	41.61	1.605	"	15.48	10.81	16.65	1.374	"
11.30	14.76	40.52	1.596	"	12.23	13.00	22.53	1.427	"
14.03	14.60	37.10	1.605	"	11.19	14.77	26.81	1.482	"
14.96	14.11	34.53	1.605	"	10.11	15.94	29.56	...	"
0.0	9.54	56.28	1.525	E + F	9.71	17.60	33.58	...	"
3.77	9.65	53.03	1.555	"	7.80	19.93	38.62	...	"
7.13	8.43	41.93	1.555	"	6.53	21.54	41.65	...	"
10.12	8.07	50.11	1.571	"	4.80	23.41	45.81	...	A + B + F
13.56	7.41	47.35	1.590	"	11.12	20.79	43.28	...	A + F + G
16.52	6.83	44.54	1.599	"	11.55	20.24	42.56	...	A + G
21.23	6.20	41.10	1.612	"	18.26	15.43	37.59	...	"
23.28	5.47	38.44	1.610	"	19.76	14.79	36.60	1.622	"
23.68	5.06	38.69	1.618	"	27.03	10.85	31.10	1.641	"
25.37	4.89	37.34	1.630	"	30.87	9.33	29.86	1.655	"
29.95	3.50	34.15	1.647	"	36.27	7.30	26.63	1.653	"
33.50	2.53	31.27	1.659	"	45.57	5.63	19.40	1.684	"
37.67	1.80	29.08	1.653	" A ^c	48.11	5.40	18.39	...	"
40.95	1.28	26.85	1.665	"	0.0	25.95	51.23	...	F + G
43.15	1.19	25.88	1.670	"	3.16	24.36	48.75	...	"
0.0	2.79	62.84	1.549	F + G	4.85	23.11	48.21	...	"
4.21	2.03	61.12	1.468	"	5.42	23.64	48.00	...	"
6.93	1.56	59.56	1.487	"	7.34	22.69	46.43	...	"
9.97	1.24	56.75	1.481	"	9.38	21.77	45.01	...	"
14.03	0.99	54.0	1.499	"	11.12	20.79	43.28	...	A + G + G
A $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$				D $\text{Ca}_3(\text{PO}_4)_2$	G $\text{Ca}(\text{NO}_3)_2$				
B CaHPO_4				E $\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$					
C $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$				F $\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$					

THE SYSTEM CALCIUM NITRATE - CALCIUM THIOSULFATE - WATER
 (Kremann and Rodemund, 1914)

Results at 9°			Results at 25°		
Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
$\text{Ca}(\text{NO}_3)_2$	CaS_2O_3	Solid Phase	$\text{Ca}(\text{NO}_3)_2$	CaS_2O_3	Solid Phase
46.02	5.46	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	54.03	4.27	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
45.68	6.81	" + $\text{CaS}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$	50.25	9.10	"
27.92	10.46	$\text{CaS}_3\text{O}_2 \cdot 6\text{H}_2\text{O}$	45.92	13.00	" + $\text{CaS}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$
10.49	22.81	"	42.93	13.83	$\text{CaS}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$
...	29.33	"	32.01	17.09	"
			19.51	23.78	"
			8.15	29.85	"

Ca CALCIUM

THE SYSTEM CALCIUM NITRATE - POTASSIUM NITRATE - WATER

Results at 0° (Frowein, 1928)			Results at 20° (Frowein, 1928)		
Gms. per 100 gms. H ₂ O			Gms. per 100 gms. H ₂ O		
KNO ₃	Ca(NO ₃) ₂	Solid Phase	KNO ₃	Ca(NO ₃) ₂	Solid Phase
0.0	96.0	Ca(NO ₃) ₂ ·4H ₂ O	0.0	127.5	Ca(NO ₃) ₂ ·4H ₂ O
6.15	98.5	"	8.95	131.0	"
15.1	106.0	"	22.4	135.0	"
21.9	109.0	"	34.2	138.5	"
NO 31.4	116.5	"	49.7	141.0	"
39.5	120.0*	" + KNO ₃	59.5	141.5	"
34.8	109.0	KNO ₃	65.0	142.0†	" + KNO ₃
31.5	97.6	"	60.6	133.3	KNO ₃
26.3	83.1	"	50.47	117.41	"
21.3	69.6	"	41.25	82.46	"
18.9	56.0	"	33.70	57.00	"
15.9	43.0	"	30.12	44.92	"
13.4	28.6	"	28.75	15.88	"
13.8	0.0	"	31.8	0.0	"

* d₀ = 1.625† d₂₀ = 1.680

Results at 25° (Hamid and Das, 1930)			Results at 30° (Baubaudy, 1923)		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Ca(NO ₃) ₂	KNO ₃	Solid Phase	Ca(NO ₃) ₂	KNO ₃	Solid Phase
57.98	0.0	Ca(NO ₃) ₂ ·4H ₂ O	59.70	0.0	Ca(NO ₃) ₂ ·4H ₂ O
56.86	2.64	"	57.0	10.3	"
54.82	7.37	"	58.67	16.86	"
53.26	10.72	"	58.9	17.2	"
49.16	19.06	" + KNO ₃	61.5	17.7	"
40.34	19.22	KNO ₃	64.4	14.2	"
31.95	19.45	"	66.0	13.0	" + Ca(NO ₃) ₂ ·?H ₂ O
19.14	20.32	"	58.3	22.4	Ca(NO ₃) ₂ ·?H ₂ O
17.34	20.70	"	50.6	31.8	Ca(NO ₃) ₂ ·?H ₂ O
11.48	21.53	"	52.0	30.4	" + KNO ₃
7.37	22.19	"	47.87	25.1	KNO ₃ + ?
4.96	23.83	"	37.22	22.4	KNO ₃
2.12	24.85	"	31.9	22.15	"
0.0	27.30	"	24.8	22.8	"
			18.15	24.0	"
			8.7	27.0	"

THE SYSTEM CALCIUM NITRATE - SODIUM NITRATE - WATER
Data of Frowein, 1928

Results at 0°			Results at 20°		
Gms. per 100 gms. H ₂ O			Gms. per 100 gms. H ₂ O		
NaNO ₃	Ca(NO ₃) ₂	Solid Phase	NaNO ₃	Ca(NO ₃) ₂	Solid Phase
4.70	96.0	Ca(NO ₃) ₂ ·4H ₂ O	4.7	128.0	Ca(NO ₃) ₂ ·4H ₂ O
9.90	97.0	"	16.1	130.0	"
17.00	96.0	"	18.9	129.5	"
21.80	97.0	"	24.1	130.2	"
26.90	97.5*	" + NaNO ₃	29.0	130.0†	" + NaNO ₃
26.17	92.65	NaNO ₃	31.3	112.0	NaNO ₃
28.25	81.50	"	34.4	101.1	"
31.81	72.10	"	39.0	88.5	"
35.00	63.17	"	42.0	78.50	"
39.60	52.88	"	47.2	72.0	"
44.10	40.66	"	54.95	47.60	"
57.50	35.67	"	62.85	38.60	"
59.32	22.70	"	69.80	25.78	"
68.70	11.20	"	81.66	10.00	"
71.74	5.73	"	88.0	0.0	"
73.00	0.0	"			

* d₀ = 1.545† d₂₀ = 1.615

Data of Kremann and Rodemund, 1914

Results at 9°			Results at 25°		
Sat. sol. wt. %		Solid Phase	Sat. sol. wt. %		Solid Phase
Ca(NO ₃) ₂	NaNO ₃		Ca(NO ₃) ₂	NaNO ₃	
47.51	9.51	Ca(NO ₃) ₂ ·4H ₂ O	54.58	7.25	Ca(NO ₃) ₂ ·4H ₂ O
46.08	12.56	" + NaNO ₃	53.22	10.70	"
26.67	23.32	NaNO ₃	52.73	12.08	" + NaNO ₃
11.76	34.26	"	52.40	11.88	NaNO ₃
			37.31	19.48	"
			26.91	24.98	"
			14.61	36.12	"

Data of Pelling and Robertson, 1923

Results at 50°			Results at 94° .5		
Sat. sol. wt. %		Solid Phase	Sat. sol. wt. %		Solid Phase
Ca(NO ₃) ₂	NaNO ₃		Ca(NO ₃) ₂	NaNO ₃	
73.8	0.0	Ca(NO ₃) ₂ ·3H ₂ O	78.4	0.0	Ca(NO ₃) ₂
69.4	11.1	" + NaNO ₃	74.6	4.3	"
62.7	11.5	NaNO ₃	69.9	14.3	"
54.7	14.8	"	67.2	17.4	"
52.8	14.4	"	66.7	18.0	" + NaNO ₃
52.3	14.9	"	60.2	17.8	NaNO ₃
39.2	21.0	"	47.0	24.7	"
30.7	27.4	"	20.5	43.9	"
22.6	34.5	"	0.0	62.6	"

Ca CALCIUM

THE SYSTEM CALCIUM NITRATE - AMMONIUM NITRATE - WATER
(Lamberger and Paris, 1948, 1950 (0, 10, 20, 30, 40°);
Flatt and Fritz, 1950 (25°))

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
NH ₄ NO ₃	Ca(NO ₃) ₂	Density	NH ₄ NO ₃	Ca(NO ₃) ₂	Density	NH ₄ NO ₃	Ca(NO ₃) ₂	Density
Results at 0°			Results at 10°--Cont.			Results at 20°--Cont.		
Solid Phase NH ₄ NO ₃			Solid Phase Ca(NO ₃) ₂ ·4H ₂ O			Solid Phase Ca(NO ₃) ₂ ·4H ₂ O		
53,6	0	1,2620	26,7	45,6*	1,6405	13,3	51,3	1,6095
47,4	8,0	1,3105	23,5	46,0	1,6170	11,3	51,6	....
42,0	15,4	1,3610	20,2	46,5	1,5970	10,0	52,4	1,5920
37,8	21,3	1,4065	13,4	47,3	1,5685	6,1	53,1	....
33,0	31,5	1,4960	10,8	47,9	1,5585	3,6	53,9	1,5685
29,8	41,4c	1,6100	7,3	48,9	1,5460	0	54,7	1,5565
			0	51,5	1,5230			
Solid Phase Ca(NO ₃) ₂ ·4H ₂ O			Results at 20°			Results at 30°		
Solid Phase NH ₄ NO ₃			Solid Phase NH ₄ NO ₃			Solid Phase NH ₄ NO ₃		
29,3	41,2	....	65,2	0	1,3090	70,0	0	1,3285
25,8	41,9	1,5895	58,0	7,4	1,3550	65,7	4,5	1,3550
19,1	43,3	1,5600	51,0	15,0	1,3990	61,2	9,3	....
19,4	43,1	1,5605	45,2	23,6	1,4625	57,6	13,1	....
7,0	46,4	1,5170	40,4	31,1	1,5280	54,0	17,4	....
0	48,0	1,4945	37,5	38,0	1,6010	48,8	23,7	....
Results at 10°			37,4	39,0	1,6110	43,3	33,9	1,5810
Solid Phase NH ₄ NO ₃			37,1	39,5	....	41,3	38,6	1,6290
59,6	0	1,2860	37,0	41,1b	1,6380	41,9	39,3b	1,6385
52,3	7,9	1,3310	Solid Phase 1:1:2			Solid Phase 1:1:2		
46,3	16,4	1,3875	34,7	42,1	....	41,5	39,7	....
41,1	24,0	1,4480	34,3	42,5	1,6415	41,1	40,0	....
37,3	32,2	1,5180	33,9	42,8	....	39,8	40,4	....
33,8	40,4	1,6025	32,3	44,2	....	38,4	41,3	....
33,7	42,0b	1,6350	29,8	45,4	....	37,9	41,9	....
Solid Phase 1:1:2			29,5	45,6a	1,6500	34,0	44,8	....
32,5	42,7	....	26,7	47,5*	1,6535	33,9	44,8a	1,6570
28,1	45,0	1,6400	24,3	48,8*	1,6620	23,0	52,3*	1,6830
27,4	45,5a	1,6415	17,6	54,6*	1,6635	16,0	57,7*	....
27,7	45,9*	1,6425	Solid Phase 1:5:10			Solid Phase 1:5:10		
23,9	48,1*	1,6520	29,0	45,5	1,6480	33,8	44,8	....
22,0	50,0*	1,6590	28,8	45,6	....	32,1	45,6	1,6540
Solid Phase 1:5:10			27,5	46,5	1,6465	28,9	47,4	....
27,2	45,5	1,6410	25,5	47,4	....	24,9	48,5	....
26,6	45,6c	1,6400	23,0	48,8	1,6435	24,8	48,5	....
28,1	45,7*	1,6425	22,6	49,6	....	22,6	50,3	....
26,6	45,6*	1,6400	21,9	49,7	....	18,8	52,1	....
21,0	48,0*	1,6360	18,2	51,0c	1,6380	17,0	52,9	....

(Cont.)

a = 1:5:10 also present. b = 1:1:2 also present. c = Ca(NO₃)₂·4H₂O also present. d = 1:1:3 also present. e = NH₄NO₃ also present.
1:1:2 = NH₄NO₃·Ca(NO₃)₂·2H₂O. 1:1:3 = NH₄NO₃·Ca(NO₃)₂·3H₂O.
1:5:10 = NH₄NO₃·5Ca(NO₃)₂·10H₂O. *Metastable

THE SYSTEM CALCIUM NITRATE - AMMONIUM NITRATE - WATER--Cont.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
NH ₄ NO ₃	Ca(NO ₃) ₂	Density	NH ₄ NO ₃	Ca(NO ₃) ₂	Density	NH ₄ NO ₃	Ca(NO ₃) ₂	Density
Results at 30°--Cont.			Results at 40°--Cont.			Results at 25°--Cont.		
Solid Phase 1:5:10--Cont.			Solid Phase 1:5:10--Cont.			Solid Phase 1:5:10--Cont.		
11,6	55,9	....	13,5	55,9	....	20,06	51,68*	....
9,5	56,7c	1,6460	10,6	57,3	....	22,50	50,40*	....
8,5	57,2*	1,6455	9,0	57,8	....	22,96	50,23*	....
Solid Phase Ca(NO ₃) ₂ ·4H ₂ O			8,5	59,1	....	Solid Phase 1:1:3		
14,3	57,1*	1,697	7,7	59,4	....	17,45	52,83a	NO
7,5	56,8	1,6450	3,5	61,5	....	21,22	49,54	
0	58,9	1,6000	2,0	62,8c	....	27,21	45,41	
Results at 40°			Solid Phase Ca(NO ₃) ₂ ·4H ₂ O			33,29	41,56	....
Solid Phase NH ₄ NO ₃			2,2	63,8*	....	40,25	38,22e	....
73,5	0	....	3,3	66,1*	....	Solid Phase 1:1:2*		
68,5	5,4	....	2,8	67,6*	....	18,71	56,07c*	....
64,2	9,0	....	2,5	68,4*	....	20,35	54,46*	....
60,1	13,3	....	0,1	72,1*	....	24,54	50,97*	....
54,6	21,3	....	1,7	63,0	....	25,08	50,71*	....
54,1	21,5	....	0,3	64,2	....	28,86	48,19*	....
49,0	31,4	....	0	64,3	....	34,85	44,40*	....
47,7	35,3	....	Results at 25°			35,91	43,72*	....
46,0	39,4	....	Solid Phase Ca(NO ₃) ₂ ·H ₂ O			39,48	41,49e*	....
45,6	41,3b	....	0,0	57,38	....	39,53	41,49e*	....
Solid Phase 1:1:2			7,82	55,39	....	Solid Phase NH ₄ NO ₃		
44,3	41,1	....	13,33	54,81	....	39,48	41,49b*	....
36,4	44,8	....	13,66	54,78a	....	39,53	41,49b*	....
32,9	46,8	....	18,10	55,36*	....	40,10	38,95*	....
27,8	49,4	....	18,71	56,07b*	....	40,25	38,22d	....
27,0	50,3a	....	Solid Phase 1:5:10			40,90	36,28	....
26,8	50,4	....	6,47	58,79*	....	43,72	30,78	....
24,8	53,8	....	8,53	57,70*	....	54,20	15,30	....
Solid Phase 1:5:10			13,66	54,78c	....	57,10	11,84	....
25,6	50,8	....	16,57	53,14	....	67,45	0,0	....
21,5	52,0	....	17,45	52,83d	....		

a = 1:5:10 also present. b = 1:1:2 also present. c = Ca(NO₃)₂·4H₂O also present. d = 1:1:3 also present. e = NH₄NO₃ also present.
 1:1:2 = NH₄NO₃·Ca(NO₃)₂·2H₂O. 1:1:3 = NH₄NO₃·Ca(NO₃)₂·3H₂O.
 1:5:10 = NH₄NO₃·5Ca(NO₃)₂·10H₂O.

*Metastable

Ca CALCIUM

THE SYSTEM CALCIUM NITRATE - STRONTIUM NITRATE - WATER
(Kobe and Stewart, 1942)

Results at 60°

Results at 60°

	Gms. per 100 gms. Sat. Sol.		Solid Phase	Gms. per 100 gms. Sat. Sol.		Solid Phase
	Sr(NO ₃) ₂	Ca(NO ₃) ₂		Sr(NO ₃) ₂	Ca(NO ₃) ₂	
NO	44.50	0.0	Sr(NO ₃) ₂ ·4H ₂ O	48.25	0.0	Sr(NO ₃) ₂
	32.30	12.23	" + Sr(NO ₃) ₂	15.42	33.04	"
	27.70	17.60	Sr(NO ₃) ₂	4.20	51.00	"
	19.90	25.90	"	0.14	70.20	"
	9.25	39.15	"	.084	76.00	"
	6.54	44.00	"	.07	76.96	Ca(NO ₃) ₂ + Sr(NO ₃) ₂
	4.85	46.90	"	0.0	77.15	Ca(NO ₃) ₂
	4.71	47.05	"			
	4.1	48.10	"			
	1.55	56.10	" + Ca(NO ₃) ₂ ·4H ₂ O			
	0.0	57.20	Ca(NO ₃) ₂ ·4H ₂ O			

THE SYSTEM Ca(NO₃)₂ + 2KCl \rightleftharpoons CaCl₂ + 2KNO₃ AT 30°
(Baubaudy, 1923)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	Ca(NO ₃) ₂	KCl		Ca(NO ₃) ₂	KCl	
	62.4	4.8	Ca(NO ₃) ₂ ·4H ₂ O	39.0	15.83	KNO ₃
	65.6	6.37	"	34.56	16.0	"
	73.5	9.0	" + Ca(NO ₃) ₂ ·?H ₂ O	27.18	17.14	"
	59.9	13.85	Ca(NO ₃) ₂ ·?H ₂ O	23.87	18.3	"
	52.35	16.0	"	20.17	20.54	"
	47.83	17.56	"	17.31	23.4	"
	45.8	18.2	" + KNO ₃	16.2	24.6	" + KCl
	44.33	16.7	KNO ₃	14.65	24.74	KCl
	44.2	16.6	"	8.22	25.8	"

Data are given for the following quaternary systems in water:

System	Temp.	Author
Ca(NO ₃) ₂ + Na ₂ S ₂ O ₃ \rightleftharpoons CaS ₂ O ₃ + 2NaNO ₃	9°, 25°	(Kremann and Rodemund, 1914)
Ca(NO ₃) ₂ + KNO ₃ + NaNO ₃	0°, 20°	(Frowein, 1928)
Ca(NO ₃) ₂ + NH ₄ NO ₃ + HNO ₃	25°	(Flatt and Fritz, 1941)
3Ca(NO ₃) ₂ + 2H ₃ PO ₄ \rightleftharpoons Ca ₃ (PO ₄) ₂ + 6HNO ₃	0°	(Flatt, Brunisholz and Fell, 1954)
" " " "	25°	(Flatt, Wilhelm, Brunisholz and Fell, 1954)
" " " "	50°	(Flatt, Brunisholz and Denereaz, 1956)
Ca(NO ₃) ₂ + CaHPO ₄ + NH ₄ NO ₃ + HNO ₃	25°	(Flatt, Brunisholz and Jaunin, 1954)
Ca(NO ₃) ₂ + Mg(NO ₃) ₂ + H ₃ BO ₃	-30, -20, -10, 0, 10, 20, 60°	(Goltschapov, 1953)

THE SYSTEM CALCIUM NITRATE - UREA
DETERMINED BY THE FREEZING-POINT METHOD
(Howells, 1931)

t°	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. sat. sol.	Solid Phase
142.2	47.2	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{CO}(\text{NH}_2)_2$
144.6	45.6	"
147.2	44.2	"
151.5 (m. pt.)	40.5	"
151.3	40.13	"
143.1	34.55	"
117.7	26.88	"
96.3	23.18	"
88 (Eutec.)	21.0	" + $\text{CO}(\text{NH}_2)_2$
90.7	20.04	$\text{CO}(\text{NH}_2)_2$
100.5	18.04	"
111.7	12.62	"
121.6	7.45	"
127.0	3.90	"
132.2	0.0	"

NO

THE SYSTEM CALCIUM NITRATE - UREA - WATER AT 25°
(Sakai, 1940a)

Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Ca}(\text{NO}_3)_2$	$\text{CO}(\text{NH}_2)_2$	
0.0	54.5	$\text{CO}(\text{NH}_2)_2$
4.64	54.62	"
6.32	55.46	"
10.80	56.21	"
14.88	56.35	"
*18.20	59.5	$\text{CO}(\text{NH}_2)_2 + \text{Ca}(\text{NO}_3)_2 \cdot 4\text{CO}(\text{NH}_2)_2$
19.17	59.90	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{CO}(\text{NH}_2)_2$
19.87	58.44	"
21.98	51.92	"
28.24	39.41	"
39.07	31.21	"
46.15	21.87	"
52.30	18.49	"
54.86	15.93	"
56.14	15.98	"
*60.5	11.2	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{CO}(\text{NH}_2)_2 + \text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
59.33	10.28	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
60.04	6.4	"
59.64	5.39	"
58.45	2.26	"
59.70	0.0	"

*Average of several determinations in fair agreement with each other.

Ca CALCIUM

SOLUBILITY OF CALCIUM NITRATE IN METHYL ALCOHOL (Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928)

t°	Gms. Ca(NO ₃) ₂ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. Ca(NO ₃) ₂ per 100 gms. CH ₃ OH	Solid Phase
10	134.1	Ca(NO ₃) ₂ ·2CH ₃ OH	70	168.5	Ca(NO ₃) ₂ ·2CH ₃ OH
40	144.2	"	72	170.7	" + Ca(NO ₃) ₂
60	158.0	"	73	171.7	CaNO ₃
			80	169.3	"

NO D'Ans and Siegler, 1913 give 65.5 g (Ca(NO₃)₂ per 100 gms. sat. soln. in methanol at 25°, not in agreement with the above.

SOLUBILITY OF CALCIUM NITRATE IN ETHYL ALCOHOL (Lloyd, Brown, Glynwyn, Bonnell and Jones, 1923)

t°	Gms. Ca(NO ₃) ₂ per 100 gms. C ₂ H ₅ OH	Solid Phase	t°	Gms. Ca(NO ₃) ₂ per 100 gms. C ₂ H ₅ OH	Solid Phase
10	46.2	Ca(NO ₃) ₂ ·2C ₂ H ₅ OH	50	73.5	Ca(NO ₃) ₂ ·2C ₂ H ₅ OH
20	51.4	"	60	82.1	"
30	56.2	"	70	90.1	Ca(NO ₃) ₂
40	62.9	"	80	91.8	"

Ferner and Mellon (1934) give 85.4 gm. per 100 gms. ethanol at 25°, not in agreement with the above.

SOLUBILITY OF CALCIUM NITRATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25° (D'Ans and Siegler, 1913)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
C ₂ H ₅ OH	Ca(NO ₃) ₂	Solid Phase	C ₂ H ₅ OH	Ca(NO ₃) ₂	Solid Phase
0	57.5	Ca(NO ₃) ₂ ·4H ₂ O	15.2	69.52	Ca(NO ₃) ₂ unstable
8.1	55.2	"	20.4	66.08	" "
14.1	52.9	"	35.9	57.7	" "
22.3	50.2	"	41.8	51.4	" "
29.4	49	"	27.39	61.96	Ca(NO ₃) ₂ stable
31.2	52	"	28.5	61.15	" "
29.5	56.2	"	29.6	60.3	" + Ca(NO ₃) ₂ ·2C ₂ H ₅ OH
27.8	60	"	60.2	38.6	Ca(NO ₃) ₂ ·2C ₂ H ₅ OH
26.5	62.3	" + Ca(NO ₃) ₂	54.6	41.9	"
0	82.5	Ca(NO ₃) ₂ unstable	42.5	50.97	"
5.8	77	" "	35.8	55.3	"

SOLUBILITY OF CALCIUM NITRATE IN OTHER ALCOHOLS

Solvent	t°	Solubility	Author	NO
Propyl alcóhol	25	36.5 gm. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. sat. sol.	(D'Ans and Siegler, 1913)	
i-Propyl "	25	2.60 gm. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. sat. sol.	(Ferner and Mellon, 1934)	
i-butyl "	25	25.0 gm. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. sat. sol.	(D'Ans and Siegler, 1913)	
Amyl "	25	13.3 gm. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. sat. sol.	(D'Ans and Siegler, 1913)	
Amyl "	25	5.6 gms. $\text{Ca}(\text{NO}_3)_2$ per 100 cc. solvent	(Müller, Printer and Preet, 1925)	
i-Amyl "	Room	3.73 gms. $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ per 100 cc. sat. sol.	(Rothschild, Templeton and Hall, 1948)	
i-Amyl "	25	4.55 gms. $\text{Ca}(\text{NO}_3)_2$ per 100 cc. solvent	(R. Müller, 1924)	

DISTRIBUTION OF $\text{Ca}(\text{NO}_3)_2$ BETWEEN n HEXYL ALCOHOL AND WATER AT 25°
(Templeton and Daly, 1951)

Weight Percentage

Aqueous Phase		Alcoholic Phase	
$\text{Ca}(\text{NO}_3)_2$	H_2O	$\text{Ca}(\text{NO}_3)_2$	H_2O
57.2	39.1	3.01	2.85 = (Saturated with $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$)
55.0	44.1	1.94	2.75
54.5	43.7	1.64	2.87
50.4	45.8	0.945	3.04

SOLUBILITY OF CALCIUM NITRATE IN ACETONE
(Bell, Rowlands, Bamford, Thomas and Jones, 1930)

Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 gms.			Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 gms.		
t°	CH_3COCH_3	Solid Phase	t°	CH_3COCH_3	Solid Phase
0	20.9	$\text{Ca}(\text{NO}_3)_2 \cdot \text{C}_3\text{H}_6\text{O}$	30	17.1	$\text{Ca}(\text{NO}_3)_2 \cdot \text{C}_3\text{H}_6\text{O}$
10	17.0	"	40	17.2	"
20	16.8	"	50	18.4	"

D'Ans and Siegler, 1913 give 58.5 gms. $\text{Ca}(\text{NO}_3)_2$ per 100 gms. Acetone, not in agreement with the above.

Ca CALCIUM

THE SYSTEM CALCIUM NITRATE - ACETIC ACID DETERMINED BY THE SYNTHETIC METHOD (Davidson and Geer, 1938)

t°	Mole. Ca(NO ₃) ₂ per 100 mols. Ca(NO ₃) ₂ + CH ₃ COOH	Solid Phase	t°	Mols. Ca(NO ₃) ₂ per 100 mols. Ca(NO ₃) ₂ + CH ₃ COOH	Solid Phase
30.3	7.87	1.3	14.37	8.90*	CH ₃ COOH
32.0	8.27	"	14.83	7.87*	"
33.5	8.71	"	15.18	6.57	"
33.9	8.90	"	15.60	4.59	"
			15.72	3.65	"
NO 1.3 = Ca(NO ₃) ₂ .3CH ₃ COOH			15.86	2.70	"
	unstable equilibrium				

SOLUBILITIES OF CALCIUM NITRATE IN CELLOSOLVES

Solubility expressed as grams anhydrous calcium nitrate per 100 grams solvent; T = transition point of disolvate; M = congruent melting point of disolvate; m = metastable.

t, °C.	Methyl g./100 g.	Cello- solve solvate	Ethyl g./100 g.	Cello- solve solvate	Butyl g./100 g.	Cello- solve solvate
30.0	33.2	2	5.9	2	58.4	0
45.0	41.5	2	12.7	2	52.5	0
60.0	50.3	2	22.3	2	46.9	0
75.0	65.2	2	40.1	2	41.5	0
82.5	77.4	2	54.9	2		
87.2	91.8	2				
87.5			64.0	2		
88.8	114.2	2,1 T				
89.2	107.83	2 M				
90.0	130.6	0 M			35.4	0
91.1			80.1	2		
91.2			81.2	2,0 T		
93.8	122.2	1				
95.0			78.6	0		
96.5	126.5	1				
105.0	125.6	0	75.3	0	31.1	0
120.0	123.4	0	71.1	0	27.2	0

100 cc of a saturated solution of Calcium Nitrate in Furfural contains 0.44 gms. Ca(NO₃)₂.4H₂O at 25°. (Trimble, 1941).

100 cc of a saturated solution of Calcium Nitrate in Methyl-n Hexyl Ketone contains less than 0.1 gm. Ca(NO₃)₂.4H₂O at room temperature.

At room temperature the distribution ratio of Calcium Nitrate between Methyl n-Hexyl Ketone and Water is 0.012 when there is 31.9 wt. % Ca(NO₃)₂ in the water phase. (Rothschild, Templeton and Hall, 1948).

100 cc. pyridine dissolve 5.75 gms. Ca(NO₃)₂ at 25°. (Muller, R., 1924).

100 gms. of a saturated solution in methyl acetate (d = 1.313) contain 41 gms. Ca(NO₃)₂ at 18°. (Naumann, 1909).

SOLUBILITY OF CALCIUM NITRATE IN LIQUID AMMONIA
(Portnow and Wassilev, 1935; Portnow and Schorawlew, 1935)

t°	Gms. Ca(NO ₃) ₂ per 100 gms.		t°	Gms. Ca(NO ₃) ₂ per 100 gms.		
	NH ₃	Solid Phase		NH ₃	Solid Phase	
-69.5	59.1	Ca(NO ₃) ₂ ·6½NH ₃ (?)	-9.5	83.2	Ca(NO ₃) ₂ ·4NH ₃	
-67	59.7	"	0*	...	"	
-63	62.7	"	+14.0	89.2	"	
-51	70.5	"	18.0	92.3	"	
-41	76.0	Ca(NO ₃) ₂ ·4NH ₃	25†	...	"	
-19.5	79.2	"	48.5	111.0	Ca(NO ₃) ₂	
			53	111.5	"	NO

* 100 gms. Liquid Ammonia dissolve 82.2 gms. Ca(NO₃)₂ at 0°. (Linhard and Stephan, 1933, 1934).

† 100 gms. Liquid Ammonia dissolve 80.2 gms. Ca(NO₃)₂ at 25°. (Hunt and Boncyk, 1933).

Melting points have been determined in the following systems:

Ca(NO ₃) ₂ + KNO ₃ (1)(2)(6)(12)	Ca(NO ₃) ₂ + Cd(NO ₃) ₂ (5)
Ca(NO ₃) ₂ + NaNO ₃ (1)(8)(9)(10)(12)	Ca(NO ₃) ₂ + LiNO ₃ (8)(9)
Ca(NO ₃) ₂ + Mg(NO ₃) ₂ (1)	Ca(NO ₃) ₂ + NaNO ₃ + Pb(NO ₃) ₂ (10)
Ca(NO ₃) ₂ + Mg(NO ₃) ₂ + KNO ₃ (1)	Ca(NO ₃) ₂ + NaNO ₃ + Sr(NO ₃) ₂ (10)
Ca(NO ₃) ₂ + Mg(NO ₃) ₂ + NaNO ₃ (1)	Ca(NO ₃) ₂ + CsNO ₃ (11)
Ca(NO ₃) ₂ + KNO ₃ + NaNO ₃ (1)	Ca(NO ₃) ₂ + CsNO ₃ + RbNO ₃ (11)
Ca(NO ₃) ₂ + KNO ₃ + NaNO ₃ + Mg(NO ₃) ₂ (1)	
Ca(NO ₃) ₂ + KNO ₃ + NaNO ₃ (3)(7)	
Ca(NO ₃) ₂ + Guanidine Nitrate (4)	

(1) Janecke, 1942. (2) Kitrov, 1949. (3) Berman, 1943. (4) Clark and Esterbrook, 1949. (5) Hasselblatt, 1921. (6) Rostkowski, 1929, 1930. (7) Menzies and Dutt, 1911. (8) Lehrman and Brealow, 1938. (9) Lehrman et. al., 1937. (10) Laybourn, Madgin and Freeman, 1934. (11) Protzenko and Belova, 1955. (12) Protzenko and Bergman, 1950.

CALCIUM NIOBATE Ca(NbO₃)₂

NbO

At 15°, one liter of saturated solution in water contains 0.00525 gms. Ca(NbO₃)₂·2H₂O. (Krylov and Alekseev, 1955).

CALCIUM OXIDE CaO

O

CALCIUM HYDROXIDE Ca(OH)₂

OH

Data are given for the following systems:

CaO + SiO ₂	Kolobova (1941)
CaO + MnO	Jay and Andrews (1944), Pettersson (1946)
CaO + V ₂ O ₅	Morozov (1938)
CaO + CaC ₂	Aall (1939)
CaO + Fe ₂ O ₃ (Slag)	Hay and White (1940), Sosman and Merwin (1916)
CaO + SiO ₂ + P ₂ O ₅	Barrett and McCaughey (1942, 1944), Tromel (1943)
	Schleede (1942), Tromel, Harkort and Hotop (1948)

Ca CALCIUM

Data are given for the following systems:--Cont.

$\text{CaO} + \text{SiO}_2 + \text{Na}_2\text{O}$	Lukesh' (1948)
$\text{CaO} + \text{SiO}_2 + \text{Fe}_2\text{O}_3$	Burdick (1940)
$\text{CaO} + \text{SiO}_2 + \text{Al}_2\text{O}_3$	Clark (1946), Rankin and Wright (1915)
$\text{CaO} + \text{TiO}_2$	Devries, Roy and Osborn (1954)
$\text{CaO} + \text{MgO}$	Ranking and Merwin (1916)
$\text{CaO} + \text{MgO} + \text{Al}_2\text{O}_3$	
$\text{CaO} + \text{MgO} + \text{SiO}_2$	Bowen (1914)
$\text{CaO} + \text{C} + \text{CaC}_2 + \text{CO}$	Thompson. (1910)
$\text{CaO} + \text{UO}_2$	Alberman, Blakey and Anderson, 1951
$\text{CaO} + \text{Cr}_2\text{O}_3 + \text{Cr}$	Ol'shanskii, Tsvetkov and Shlepov, 1954

- 0 See also: Eitel (1941): $\text{CaO} + 5\text{CaO} \cdot \text{Al}_2\text{O}_3 + \text{CaF}_2$, Eubank and Bogue (1948): $\text{Na}_2\text{O} + 4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{FeO} + \text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3$, Parker and Nurse (1943): part of $\text{CaO} + \text{MgO} + \text{SiO}_2$, Vasenin (1939): $\text{CaO} \cdot \text{Cr}_2\text{O}_3 + \text{CaO} \cdot \text{Al}_2\text{O}_3$, Vasenin (1939) and Taylor (1941): $2\text{CaO} \cdot \text{SiO}_2 + \text{K}_2\text{O} \cdot \text{CaO} \cdot \text{SiO}_2$, Machin and Yee (1948): Viscosities of $\text{CaO} + \text{Al}_2\text{O}_3 + \text{SiO}_2$, Preston (1941): $\text{Na}_2\text{O} \cdot 2\text{SiO}_2 + \text{CaO} \cdot \text{SiO}_2$, Kroger and Illner (1940): $\text{Na}_2\text{O} + \text{CaO} + \text{SiO}_2 + \text{CO}_2$, Swayze, (1946): $\text{CaO} + 5\text{CaO} \cdot 3\text{Al}_2\text{O}_3 + 2\text{CaO} \cdot \text{Fe}_2\text{O}_3$ etc.

Additional determinations for the above systems are given by Konarzewski, 1931; Ruff, Ebert and Krawczynski, 1933; Tromel, 1932 and Tromel and Korber, 1932.

Data for the solubility of CaO in molten CaCl_2 are given by Arndt and Loewenstein, 1909 and Kunitomi, 1950. The solubility in molten cryolite is given by Hayakawa and Kido, 1951.

OH

SOLUBILITY OF CALCIUM HYDROXIDE IN WATER (Bassett, 1934)

Attention has been paid in the present work particularly to the influence of particle size upon the solubility of calcium hydroxide. Freshly slacked lime is about 10 percent more soluble than lime in the form of coarse particles, and, since the growth of the particles occurs so slowly that the effect due to it is scarcely apparent when the usual tests are made to see whether true equilibrium has been reached, it is believed that this accounts for the wide variations in the results reported by different investigators. Although Miller and Witt, 1929 recognized the influence of particle size upon the solubility, their one measurement at 30° appears to be about 10 percent too high. Johnston and Grose, 1931, found 0.111 gm. CaO per 100 gms. sat. solution at 25° which is very close to the value 0.113 reported in the present paper.

The calcium hydroxide used for the present determinations was made by slacking lime prepared by igniting especially purified CaCO_3 . The solutions were mechanically shaken in silver or platinum bottles. About one month was required for freshly slacked lime to reach its limiting value of solubility at 50° . The possibility that this high initial solubility might be due to the existence of a hydrate of calcium hydroxide or of more than one crystalline form appears improbable since all attempts to prepare a monohydrate have failed. The sources of error in the gravimetric determination of calcium have been examined and it has been found that the solubility of calcium oxalate is an important factor in this determination.

SOLUBILITY OF CALCIUM HYDROXIDE IN WATER--Cont.

A series of determinations by Grieve, Gurd and Maass, 1933 and by Larocque and Maass, 1935, using freshly slacked lime and estimating solubility from electrical conductivity measurements, gave results agreeing fairly closely with the values for fine Ca(OH)_2 .

The solubility was determined as a function of particle size by Hedin, 1955 from 25° to 58°. The variation in solubility with temperature for large crystals is $S(\text{g./l.}) = 3.947 - 0.0094 K^0$. The values calculated from this equation are identical with those of Bassett, below. The variation in solubility with particle size is given by the equation $\log s_{K^0} = S_{K^0}^{\infty} + \frac{0.0136}{2}$, where $S_{K^0}^{\infty}$ is the solubility of large crystals at the temperature K^0 , and D is the particle size in μ . ON

Results of Bassett, 1934

Gms. CaO per 100 gms. solution saturated with:				Gms. CaO per 100 gms. solution saturated with:			
t^0	Coarse Ca(OH)_2	Fine Ca(OH)_2	Solid Phase	t^0	Coarse Ca(OH)_2	Fine Ca(OH)_2	Solid Phase
-0.088	0.100	...	Ice	40	0.100	0.107	Ca(OH)_2
-0.123	...	0.142	" + Ca(OH)_2	45	0.0962	...	"
-0.116	0.130	...	" + "	50	0.0917	0.0968	"
0	0.130	0.143(0.151)	Ca(OH)_2	60.8	0.0818	0.0917	"
5	0.128	0.142	"	70	...	0.0800	"
10	0.125	0.138	"	71.7	0.0657	...	"
15	0.122	0.133	"	90	0.0591	...	"
19	0.118*	...	"	95.3	0.0561	...	"
25	0.113	0.129	"	99	0.0523	...	"
30	0.109	0.121	"				

Results at higher temperatures

Gms. Ca(OH)_2 per liter			Gms. Ca(OH)_2 per liter		
t^0	(Peppler and Wells, 1954)	(Herald, 1905)	t^0	(Peppler and Wells, 1954)	(Herald, 1905)
21	1.15	...	150	0.247 coarse*	0.169
30	1.03	...		0.268 fine	
120	...	0.305	190	...	0.084
125	0.380	...	200	0.050	...
			250	0.037	...

*Shenstone and Crandall, 1883 (found 0.246 at 150°).

The following data of Haslam, Calingaert and Taylor, 1924 are typical of the results obtained when particle size is not controlled.

Equilibrium was approached from above and from below. The excess of lime was allowed to settle and the clear supernatant solution titrated, using phenolphthalein as indicator.

Ca CALCIUM

t°	Gms. CaO per 1000 gms. sat. sol.	t°	Gms. CaO per 1000 gms. sat. sol.	t°	Gms. CaO per 1000 gms. sat. sol.
10	1.310	56	0.884	66	0.802
42	1.018	60	0.855	70	0.762
48	0.957	61	0.842	80	0.673

OH Data for the solubility of commercial limes in water are given by Haslam, Whitman and Cochran, Jr. 1924. The results show that these limes do not vary more than 7 per cent from the solubility of pure calcium oxide. The differences are probably due to the presence of small amounts of sodium and potassium hydroxide in commercial limes. The content of MgO, SiO₂ or carbonate have no effect upon the solubility of ordinary lime, but may have a marked effect upon its rate of solution.

SOLUBILITY OF CALCIUM OXIDE IN SODIUM AND POTASSIUM HYDROXIDE SOLUTIONS (Results of Fratini, 1949)

In KOH Solutions				In NaOH Solutions			
KOH		CaO		NaOH		CaO	
Moles per Liter	Gms. per Liter	Moles per Liter	Gms. per Liter	Moles per Liter	Gms. per Liter	Moles per Liter	Gms. per Liter
At 20°				At 20°			
0.0206	1.156	0.0152	0.852	0.0	0.0	0.0210	1.177
.0412	2.312	.0109	.611	0.0252	1.008	.0139	0.779
.0746	4.186	.0068	.381	.0525	2.100	.0092	.516
.1048	5.836	.0049	.275	.1035	4.140	.0050	.281
.1537	8.624	.0033	.185	.1058	4.233	.0051	.286
.2120	11.900	.0027	.151	.1535	6.141	.0035	.196
				.2090	8.361	.0026	.146
At 40°				At 40°			
0.0200	1.122	0.0123	0.690				
.0737	4.135	.0050	.280	0.0	0.0	0.0180	1.010
.1012	5.680	.0036	.202	.050	2.000	.0071	.399
.1977	11.090	.0019	.010	.1495	5.980	.0025	.011

Results of d'Anselme (1903), in agreement with those above:

Concentration of NaOH:		Grams CaO per Liter Sat. Solution at:			
Normality	Gms. per Liter	20°	50°	70°	100°
0	0	1.170	0.880	0.75	0.54
0.01	0.4	0.94	0.65	0.53	0.35
.04	1.6	0.57	0.35	0.225	0.14
.067	2.66	0.39	0.20	0.11	0.05
.125	5.00	0.18	0.06	0.04	0.01
.2	8.00	0.11	0.02	0.01	trace
.5	20.00	0.02	trace	0.00	0.00

SOLUBILITY OF LIME IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE ALONE AND
CONTAINING SODIUM HYDROXIDE
(Maigret, 1905)

G. NaCl per Liter	Gms. CaO per Liter of Solution			G. NaCl per Liter	Gms. CaO per Liter of Solution			
	Without NaOH	0.89 NaOH per Liter	4.09 NaOH per Liter		Without NaOH	0.89 NaOH per Liter	4.09 NaOH per Liter	
0	1.3	0.08	0.22	150	1.65	1.25	0.44	
5	1.4	0.9	..	175	1.6	1.2	..	
10	1.6	1.0	..	182	1.6	1.2	..	
25	1.7	1.1	..	225	1.4	1.0	..	OH
50	1.8	1.25	..	250	1.3	0.9	..	
75	1.9	1.4	0.55	300	1.1	0.7	0.22	
100	1.85	1.4	..	...	...	...	..

For results upon mixtures of calcium hydroxide and alkali carbonates and hydroxides, see Rodlander, 1905.

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF
AMMONIUM HYDROXIDE AT 25°
(Kolthoff and Stenger, 1934)

d ₂₅ of sat. sol.	Normality of NH ₃	Gms. CaO per 100 cc. sat. sol.
0.998	0.0(= H ₂ O)	0.1194
0.994	0.496	0.1117
0.989	0.981	0.1038
0.985	1.475	0.0953
0.982	1.955	0.0881

One liter of aqueous 5.2% NH₃ solution dissolves 0.81 gm. Ca(OH)₂ at about 20°. (Konowalov, 1899b).

THE SOLUBILITY OF Ca(OH)₂ AND CaSO₄ IN DILUTE
ALKALI SOLUTIONS AT 25°, 30°
(Hansen and Pressler, 1947)

The solubility of Ca(OH)₂ + CaSO₄ in solutions of Na₂O or K₂O, or a mixture of the two was determined at 25° and 30°. The solubilities were the same whether Na₂O or K₂O or Na₂O + K₂O was used, and were not appreciably affected by the temperature change. The solid phase was at all times Ca(OH)₂ + CaSO₄·2H₂O. The data below were selected from many values given by the authors.

Gm. Moles Na ₂ O + K ₂ O per Liter of Aqueous Solvent	Composition of solution in Contact with Ca(OH) ₂ + CaSO ₄ ·2H ₂ O Gm. moles per liter		
	CaO	SO ₃	OH
0.0	0.0319	0.0125	0.0387
.0201	.0236	.0196	.0477
.0402	.0198	.0303	.0602
.0601	.0187	.0430	.0710

(Cont.)

Ca CALCIUM

THE SOLUBILITY OF $\text{Ca}(\text{OH})_2$ AND CaSO_4 IN DILUTE ALKALI SOLUTIONS AT 25° , 30° --Cont.

Gm. Moles $\text{Na}_2\text{O} + \text{K}_2\text{O}$ per Liter of Aqueous Solvent	Composition of solution in Contact with $\text{Ca}(\text{OH})_2 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ Gm. moles per liter		
	CaO	SO_3	OH
0.1002	0.0162	0.0710	0.0806
.5012	.0093	.2083	.1386
1.0023	.0034	.3662	.2752

OH THE SYSTEM CALCIUM HYDROXIDE - CALCIUM CHLORIDE - WATER AT 25° (Schreinemakers and Figeo, 1911)

Data for the system at 10° , 25° , 40° , 45° , 48° , and 50° are given by Milikau (1916).

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CaCl_2	CaO	Solid Phase	CaCl_2	CaO	Solid Phase
5.02	0.101	$\text{Ca}(\text{OH})_2$	33.21	0.245	$\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$
10.00	0.115	"	33.72	0.254	" + $\text{CaCl}_2 \cdot \text{CaO} \cdot 2\text{H}_2\text{O}$
15.14	0.140	"	34.36	0.173	$\text{CaCl}_2 \cdot \text{CaO} \cdot 2\text{H}_2\text{O}$
18.15	0.148	" + $\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$	38.61	0.060	"
18.01	0.152	$\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$	41.32	0.048	"
21.02	0.147	"	44.30	0.030	"
28.37	0.170	"	44.61	0.029	" + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
32.67	0.225	$\text{Ca}(\text{OH})_2?$	44.77	...	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM CHLORIDE (Zahorsky, 1893; Lunge, 1892)

Concentration of CaCl_2 Solutions, Wt. %	Grams CaO Dissolved per 100 cc. Solvent at:				
	20°	40°	60°	80°	100°
0†	0.1374	0.1162	0.1026	0.0845	0.0664
5	0.1370	0.1160	0.1020	0.0936	0.0906
10	0.1661	0.1419	0.1313	0.1328	0.1389
15	0.1993	0.1781	0.1706	0.1736	0.1842
20	0.1857*	0.2249	0.2204	0.2295	0.2325
25	0.1661*	0.3020*	0.2989	0.3261	0.3710
30	0.1630*	0.3680*	0.3664	0.4122	0.4922

* Indicates cases in which a precipitate of calcium oxychloride separated and thus removed some of the CaCl_2 from solution.

† The results in 0% CaCl_2 solutions, i.e., in pure water, are high when compared with the average results given on pp. 232, 233.

THE SYSTEM CALCIUM HYDROXIDE - CALCIUM NITRATE - WATER AT 25° AND 100°
(Bassett and Taylor, 1914; see also Cameron and Robinson, 1907a)

Cerasing wax bottles were used and more than 6 months constant agitation allowed for attainment of equilibrium at 25° and 4-14 days at 100°.

Results at 25°			Results at 100° (Con.)		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CaO	Ca(NO ₃) ₂	Solid Phase	CaO	Ca(NO ₃) ₂	Solid Phase
0.1150	0	Ca(OH) ₂	0.480	42.26	Ca(OH) ₂
0.0978	4.836	"	0.973	50.94	"
0.1074	9.36	"	1.261	53.75	"
0.1193	13.77	"	1.477	55.40	"
0.1444	22.46	"	1.476	55.43	"
0.1650	27.83	"	1.491	55.65	"
0.1931	32.94	"	1.635	56.89	" + Ca ₂ N ₂ O ₇ ·2H ₂ O
0.2579	40.66	"	1.686	57.03	
0.3060	44.44	"	1.596	57.91	Ca ₂ N ₂ O ₇ ·2H ₂ O
0.2802	45.28	Ca ₂ N ₂ O ₇ ·3H ₂ O	1.576	58.67	"
0.2314	47.79	"	1.348	60.44	"
0.1894	51.07	"	1.167	62.82	"
0.1659	53.20	"	1.077	66.44	"
0.1486	55.25	"	1.141	69.12	"
0.0836	57.72	Ca(NO ₃) ₂ ·4H ₂ O	1.252	70.60	" + a very little Ca ₂ N ₂ O ₇ · $\frac{1}{2}$ H ₂ O
0	57.98	"	1.203	70.40	Ca ₂ N ₂ O ₇ · $\frac{1}{2}$ H ₂ O
Results at 100°			1.103	71.44	"
0.0561	0	Ca(OH) ₂	0.937	73.85	"
0.0550	2.42	"	0.849	75.74	"
0.0624	4.91	"	0.815	76.94	"
0.1110	15.39	"	0.804	77.62	Ca(NO ₃) ₂
0.1200	16.10	"	0.412	77.74	"
0.155	21.86	"	0	78.43	"
0.269	33.03	"			

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM
SULFATE AT 25°
(Cameron and Bell, 1906)

The mixtures were constantly agitated at 25° for two weeks.

Gms. per 100 cc. Sat. Sol.			Gms. per 100 cc. Sat. Sol.		
CaSO ₄	CaO	Solid Phase	CaSO ₄	CaO	Solid Phase
0	0.1166	Ca(OH) ₂	0.1643	0.0939	CaSO ₄ ·2H ₂ O
0.0391	0.1141	"	0.1722	0.0611	"
0.0666	0.1150	"	0.1853	0.0349	"
0.0955	0.1215	"	0.1918	0.0176	"
0.1214	0.1242	"	0.2030	0.0062	"
0.1588	0.1222	" + CaSO ₄ ·2H ₂ O	0.2126	0	"
(0.170)	(0.104)*	" + "			

*Jones, 1939.

Ca CALCIUM

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SALT SOLUTIONS AT 25°
(Johnston and Grove, 1931)

Definitely crystalline calcium hydroxide was used, which was prepared by allowing solutions of calcium chloride and sodium hydroxide to diffuse into each other so that the crystals were built up slowly. An apparatus was used in which the liquid flowed back and forth through a column of crystals held rigidly in place, carbon dioxide was rigidly excluded. All analyses were made on the weight basis. The Ca(OH)_2 was determined by simple titration with 0.05N HCl using phenolphthaleine and methyl red as indicator, except in cases where nitrite or acetate was present, when only phenolphthalein was used.

OH	Moles per 1000 gms. H_2O			Moles per 1000 gms. H_2O			Moles per 1000 gms. H_2O		
	Salt	Ca(OH)_2	Salt	Salt	Ca(OH)_2	Salt	Salt	Ca(OH)_2	Salt
None	0.00	0.01976	LiCl	1.85	0.04239	NaClO_4	0.118	0.02325	
NaCl	0.012	0.02065	"	2.25	0.04405	"	0.399	0.02538	
"	0.064	0.02268	"	3.03	0.04643	"	0.476	0.02562	
"	0.121	0.02402	"	3.81	0.04762	"	0.776	0.02566	
"	0.366	0.02718	"	5.36	0.04845	"	1.16	0.02479	
"	0.763	0.02911	"	10.37	0.04472	"	1.58	0.02353	
"	1.21	0.02966	BaCl_2	0.019	0.02283	"	2.40	0.02046	
"	1.75	0.02933	"	0.037	0.02470	"	3.57	0.01624	
"	2.15	0.02857	"	0.066	0.02683	NaBr	0.189	0.02485	
"	2.24	0.02833	"	0.111	0.02945	"	0.348	0.02641	
"	2.81	0.02669	"	0.159	0.03157	"	0.721	0.02805	
"	3.76	0.02410	"	0.287	0.03578	"	0.979	0.02847	
KCl	0.038	0.02157	"	0.425	0.03910	"	1.30	0.02841	
"	0.076	0.02273	"	0.624	0.04246	"	1.77	0.02780	
"	0.264	0.02550	"	1.29	0.04916	"	2.90	0.02478	
"	0.527	0.02708	"	1.44	0.04991	KBr	0.162	0.02404	
"	0.989	0.02766	"	1.59	0.05022	"	0.270	0.02509	
"	1.08	0.02768	SrCl_2	0.053	0.02624	"	0.453	0.02608	
"	1.28	0.02744	"	0.120	0.03043	"	0.759	0.02669	
"	1.62	0.02696	"	0.283	0.03702	"	0.930	0.02670	
"	1.96	0.02610	"	0.445	0.04135	"	1.27	0.02636	
"	2.87	0.02351	"	0.823	0.04819	"	1.55	0.02596	
CsCl	0.073	0.02236	"	1.33	0.05336	"	2.09	0.02441	
"	0.199	0.02451	"	2.19	0.05622	"	3.24	0.02058	
"	0.537	0.02684	"	2.23	0.05623	NaI	0.085	0.02261	
"	0.862	0.02724	"	3.18	0.05537	"	0.159	0.02410	
"	1.25	0.02703	NaClO_3	0.189	0.02466	"	0.356	0.02590	
"	1.56	0.02647	"	0.386	0.02643	"	0.605	0.02678	
"	3.55	0.02056	"	0.716	0.02755	"	0.904	0.02702	
LiCl	0.054	0.02266	"	0.814	0.02765	"	1.33	0.02662	
"	0.115	0.02473	"	1.14	0.02776	"	1.60	0.02605	
"	0.249	0.02799	"	1.59	0.02731	"	1.83	0.02541	
"	0.465	0.03172	"	1.97	0.02618	"	2.11	0.02466	
"	0.830	0.03573	"	2.96	0.02352	"	2.86	0.02228	
"	1.37	0.03990	"	4.56	0.01899	"	4.21	0.01871	
NaNO_3	0.170	0.02538	NaNO_2	0.252	0.02665	$\text{NaC}_2\text{H}_3\text{O}_2$	0.188	0.02633	
"	0.217	0.02592	"	0.455	0.02894	"	0.588	0.03243	
"	0.351	0.02767	"	0.854	0.03127	"	0.692	0.03295	
"	0.510	0.02915	"	1.30	0.03255	"	0.972	0.03383	
"	0.838	0.03098	"	2.03	0.03321	"	1.01	0.03492	

(Cont.)

(Cont.)

(Cont.)

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SALT SOLUTIONS AT 25°—Cont.

Moles per 1000 gms. H ₂ O			Moles per 1000 gms. H ₂ O			Moles per 1000 gms. H ₂ O		
Salt	Salt	Ca(OH) ₂	Salt	Salt	Ca(OH) ₂	Salt	Salt	Ca(OH) ₂
NaNO ₃	1.35	0.03230	NaNO ₂	2.90	0.03322	NaC ₂ H ₃ O ₂	1.67	0.03648
"	1.76	0.03275	"	4.12	0.03204	"	3.26	0.03718
"	2.27	0.03274	"	5.82	0.02964	"	4.88	0.03497
"	2.81	0.03231				"	4.88	0.03497
"	3.78	0.03079				NH ₄ Cl	0.0	0.02022*
"	4.72	0.02931				"	0.0218	0.02908*
						"	0.0435	0.03923* OH
						"	0.0831	0.05968*

*Noyes and Chapin, 1899

Data at other temperatures

Gms. of the Chloride per Liter	In KCl Solutions			In NaCl Solutions		
	Gms. CaO per Liter at:			Gms. CaO per Liter at:		
	0°	15°	99°	0°	15°	99°
0	1.36	1.31	0.635	1.36	1.31	0.635
30	1.701	1.658	0.788	1.813	1.703	0.969
60	1.725	1.674	0.876	...	1.824	1.004
120	1.718	1.606	0.894	1.86	1.722	1.015
240	1.248	1.199	0.617	1.37	1.274	0.771
320	...	...	...	1.054	0.929	0.583

Results in harmony with the above for the solubility of calcium hydroxide in aqueous solutions of potassium chloride at 50°, are given by Kernot, d'Agostino and Pellegrino (1908).

Further data in KCl and NaCl solutions at 20° are given by Deschobenadse, Mosebach, and Naken, 1942.

THE SYSTEM CALCIUM HYDROXIDE - HYDROGEN PEROXIDE - WATER
(Makarov and Grigor'eva, 1954)

Solvent wt. %	Sat'd. Sol'n. wt. %			Solvent wt. %	Sat'd. Sol'n. wt. %		
	H ₂ O ₂	CaO	Solid Phase		H ₂ O ₂	CaO	Solid Phase
	Results at -21°				Results at -21°—Cont.		
24.5	11.5	0.81	CaO ₂ ·8H ₂ O	79.0	34.5	0.28	CaO ₂ ·2H ₂ O
26.0	11.8	0.83	"	83.0	33.1	0.33	"
28.0	13.0	0.82	"	83.6	36.2	0.21	"
30.0	12.7	0.90	"	88.0	35.7	0.18	"
32.0	14.1	0.13	CaO ₂ ·2H ₂ O ₂	95.6	38.0	0.23	"
44.0	16.9	0.38	"				
50.0	19.7	0.40	"				
52.0	21.2	0.38	"				
60.0	25.6	0.37	"	18.0	7.0	0.25	CaO ₂ ·8H ₂ O
60.5	23.2	0.37	"	25.4	10.3	0.50	"
60.0	25.0	0.55	"	27.5	9.9	0.48	" + CaO ₂ ·2H ₂ O
70.0	30.2	0.33	"	30.4	10.0	0.32	CaO ₂ ·2H ₂ O
				39.0	14.4	0.36	"

(Cont.)

Ca CALCIUM

THE SYSTEM CALCIUM HYDROXIDE - HYDROGEN PEROXIDE - WATER--Cont.

Solvent wt. %	Sat'd. Sol'n. wt. %		Solid Phase	Solvent wt. %	Sat'd. Sol'n. wt. %		Solid Phase	
	H O	CaO			H O	CaO		
	1 2O ₂				1 2O ₂			
OH	Results at -10°--Cont.			Results at 0°				
	46.0	17.7	0.36	CaO ₂ .2H ₂ O	3.8	..	0.05	CaO ₂ .8H ₂ O
	56.0	21.2	0.53	"	12.1	2.25	0.40	"
	58.0	24.6	0.36	"	12.8	3.40	0.10	CaO ₂ .2H ₂ O
	61.3	24.3	0.33	"	22.5	6.60	0.22	"
	61.3	27.0	0.36	"	26.0	8.05	0.25	"
	64.0	27.2	0.32	"	28.0	9.60	0.32	"
	68.5	29.2	0.30	"	31.0	13.2	0.61	CaO ₂ .2H ₂ O ₂
	75.0	32.5	0.25	"	31.4	9.3	0.33	"
	83.0	35.8	0.23	"	44.0	15.6	0.37	"
	84.0	36.3	0.21	"	60.0	24.5	0.37	"
	91.0	40.6	0.16	"	60.0	24.9	0.37	"
	97.0	43.5	0.10	"	70.0	29.7	0.30	"
	97.5	43.5	0.07	"	88.0	39.1	0.14	"
					96.7	30.4	0.27	"
					97.0	41.4	0.14	"

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF GLYCEROL AT 25°

(Results of Herz and Knoch, 1905)				(Results of Cameron and Patten, 1911)			
Density of Solutions	Wt. percent Glycerine in Solution	Gms. per 100 cc. Solution		d ₂₅ of Sat. Sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		Ca(OH) ₂	CaO		Ca(OH) ₂	C ₃ H ₅ (OH) ₃	
1.0003	0.0	0.1593	0.1206	0.983	0.117	0	Ca(OH) ₂
1.0244	7.15	0.3013	0.2281	1.008	0.178	3.50	"
1.0537	20.44	0.5522	0.4180	...	0.413	15.59	"
1.0842	31.55	0.8339	0.6313	1.042	0.48	17.84	"
1.1137	40.95	1.486	1.125	1.088	0.88	34.32	"
1.1356	48.7	1.631	1.234	1.149	1.34	55.04	"
1.2072	69.2	3.550	2.687				

SOLUBILITY OF CALCIUM HYDROXIDE IN SUGAR SOLUTIONS

THE SYSTEM CALCIUM HYDROXIDE, SACCHAROSE, WATER (Reinders and Van Gelder (1932) and others)

To avoid the delay in reaching equilibrium when calcium oxide is added to sugar solutions, the authors used calcium hydroxide prepared by digesting calcium oxide for some weeks in a large excess of water. This suspension was added to the sugar solution and the mixture shaken for several days. The clear saturated solutions were titrated with standard HCl and the sugar determined polarimetrically.

[An exhaustive investigation of the factors which influence the solubility of lime in sugar solutions is described by Claassen, 1911.]

SOLUBILITY OF CALCIUM HYDROXIDE IN SUGAR SOLUTIONS--Cont.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Sugar	CaO	Solid Phase	Sugar	CaO	Solid Phase
Results at 12°			Results at 25° (Cont'd)		
0.0	0.137	Ca(OH) ₂	27.2	6.72	Ca(OH) ₂
9.8	1.99	"	31.4	8.39	"
18.7	4.75	"	35.2	9.8	" + Saccharate
29.2	8.50	"	35.0	10.1	Saccharate
29.5	8.8	" + Saccharate	36.2	9.8	"
32.4	8.08	Saccharate	43.7	8.84	"
38.6	8.01	"	53.2	7.87	"
40.6	7.50	"	68.3	4.08	Saccharose
45.1	7.1	"	67.9	0.0	"
Results at 20° (Saalmann, 1933)			Results at 45°		
0.0	0.154	Ca(OH) ₂	0.0	0.102	Ca(OH) ₂
0.1	0.159	"	9.93	1.02	"
0.3	0.178	"	20.0	3.19	"
0.9	0.204	"	30.6	6.10	"
1.2	0.217	"	40.8	9.50	"
1.5	0.229	"	42.0	10.0	" + Saccharate
2.1	0.295	"	45.3	9.54	Saccharate
2.5	0.311	"	58.3	8.0	"
Results at 25°			Results at 80° (von Glinnekin, 1911)		
0.0	0.122	Ca(OH) ₂	4.90	0.117	Ca(OH) ₂
(0.62)*	(0.142)*	" (d = 1.000)*	9.90	0.189	"
2.1	0.242	"	14.75	0.230	"
4.2	0.461	"	19.50	0.358	"
(4.82)	(0.553)	" (d = 1.021)	24.60	0.548	"
6.6	0.750	"	29.70	1.017	"
(7.50)	(1.025)	" (d = 1.037)			
8.6	1.11	"			
11.8	1.86	"			
(11.90)	(2.43)	" (d = 1.067)			
15.4	2.76	"			
(17.42)	(4.07)	" (d = 1.109)			
(19.86)	(4.59)	" (d = 1.123)			
21.1	4.53	"			

OH

*Results in parentheses () are those of Cameron and Patten, 1911.

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SUGAR SOLUTIONS
IN CONTACT WITH INCREASING EXCESSES OF THE SOLID PHASE
(Doubourg, 1931)

Powdered and sifted slacked lime was added in variable measured excess to aqueous sugar solutions. The mixtures were each brought to a volume for 1000 cc and stirred in bottles filled to the neck for 3 hours. The clear saturated solutions were titrated for alkalinity using phenolphthaleine as indicator and the sugar determined in this neutralized sample.

Ca CALCIUM

SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SUGAR SOLUTIONS IN CONTACT WITH INCREASING EXCESSES OF THE SOLID PHASE—Cont.

t°	Gms. Sugar per 1000 cc of the original mixture	Gms. CaO dissolved per liter of sat. solution when the amount of CaO originally present was:		
		30 gms.	60 gms.	90 gms.
15	90	18.1 (90.2)	18.5 (90.6)	19.1 (91.7)
"	140	26.6(139.8)	33.0(141.1)	34.1(142.9)
"	200	29.2(200.0)	46.8(200.3)	49.7(203.7)
40	90	7.3 (90.7)	8.2 (92.2)	8.4 (92.3)
OH	140	14.7(142.1)	16.9(142.6)	20.0(144.6)
"	200	22.3 ...	29.5 ...	31.4 ...
60	90	3.6 (91.3)	3.8 (92.3)	4.2 (93.0)
"	140	7.5(141.4)	8.3(143.0)	8.9(145.2)
"	200	15.2(202.4)	16.1(204.4)	17.6(207.9)
80	90	0.18(91.2)	0.18(92.7)	0.18(93.8)
"	140	2.8(142.1)	2.8(144.3)	2.8(145.9)
"	200	4.5(201.8)	5.0(204.0)	5.3 ...

The figures in parentheses are the gms. sugar per liter of saturated solution. It is concluded that lime in contact with sugar solution is progressively covered with a layer of sucrate, which prevents further solution of the lime, and this process is the more rapid the higher the temperature. Hence the quantity of lime dissolved is greater at low than at high temperatures.

SOLUBILITY OF LIME IN AQUEOUS SOLUTIONS OF SUGAR (Weisberg, 1899)

The original results were plotted on cross-section paper and the following table constructed from the curves.

1st series, t° = 16°-17°.*			2d, series t° = 15°.*		
Gms. per 100 Gms. Solution		G. CaO per 100 Gms. Sugar in Sol.	Gms. per 100 Gms. Solution		G. CaO per 100 Gms. Sugar in Sol.
Sugar	CaO		Sugar	CaO	
1	0.30	35.0	1	0.50	62.5
2	0.56	28.7	2	0.75	36.0
3	0.85	28.0	3	1.02	32.5
4	1.12	27.7	4	1.22	30.2
5	1.40	27.5	5	1.45	28.5
6	1.65	27.5	6	1.67	27.7
8	2.22	27.5	8	2.22	27.5
10	2.77	27.5	10	2.77	27.5
12	3.27	27.5	12	3.27	27.5
14	3.85	27.5	14	3.85	27.5

*In the second series a very much larger excess of lime was used than in the first series. The author gives results in a subsequent paper, — Bull. soc. chim. [3] 23, 740, '00, — which show that the solubility is also affected by the condition of the calcium compound used, i.e., whether the oxide, hydrate, or milk of lime is added to the sugar solution.

SOLUBILITY OF FRESHLY PRECIPITATED CALCIUM HYDROXIDE IN DILUTE AQUEOUS
SUGAR SOLUTIONS CONTAINING NaCl AT 17°
(Fuens, 1929)

To 25 cc portions of aqueous sugar solutions of increasing concentrations, 60 cc of 1.0 normal NaOH were added, followed by 25 cc 2.0 + normal CaCl_2 . The mixtures were shaken frequently during 5 minutes and the precipitated Ca(OH)_2 removed by filtration. 50 cc portions of the clear filtrates were titrated with 1.0 normal HCl using methyl red as indicator.

Gms. per 100 cc sat. sol.		Gms. per 100 cc sat. sol.		Gms. per 100 cc sat. sol.		OH
Sugar	Ca(OH)_2	Sugar	Ca(OH)_2	Sugar	Ca(OH)_2	
0.0	0.304	0.5	0.871	1.5	0.882	
0.1	0.452	0.6	0.915	1.6	0.900	
0.2	0.545	0.7	0.943	1.7	0.904	
0.3	0.671	0.9	0.926	2.1	1.193	
0.4	0.785	1.2	0.911	2.5	1.559	
		1.4	0.893			

Data for the solubility of Ca(OH)_2 in Sucrose solutions (20-80 g./l.) containing CaCl_2 (50-200 g./l.) and (some) NaOH at 20°, 30° and 40° are given by Yokoyama, 1954.

SOLUBILITY OF Ca(OH)_2 IN GLUCOSE SOLUTIONS (Temperature not given)
(Balesin, 1946)

The solubility of Ca(OH)_2 increases without changing the pH of the solution.

Gms. Glucose per 100 ml. Sat. Sol.	Gms. CaO per 100 ml. Sat. Sol.	Gms. Glucose per 100 ml. Sat. Sol.	Gms. CaO per 100 ml. Sat. Sol.
0.0	0.112	2.0	0.264
.25	.118	5.0	.710
.5	.142	15.0	2.157
1.0	.185	20.0	2.400

EQUILIBRIUM IN THE SYSTEM CALCIUM HYDROXIDE, PHENOL AND WATER AT 25°
(Van Meurs, 1916)

Mols. per 100 mols. sat. sol.		Solid Phase	Mols. per 100 mols. sat. sol.		Solid Phase
$\text{C}_6\text{H}_5\text{OH}$	Ca(OH)_2		$\text{C}_6\text{H}_5\text{OH}$	Ca(OH)_2	
0.0	0.06	Ca(OH)_2	16.72	6.95	1.3
0.40	0.46	"	25.19	7.79	"
1.25	1.35	"	30.26	8.67	"
2.11	2.19	"	35.56	8.30	"
2.63	2.63	" + 1.3	38.38	8.21	"
4.82	4.20	1.3	53.19	7.56	"
	(Cont.)			(Cont.)	

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM HYDROXIDE, PHENOL AND WATER AT 25°--Cont.

Mols. per 100 mols. sat. sol.			Mols. per 100 mols. sat. sol.		
C_6H_5OH	$\frac{Ca(OH)_2}{2}$	Solid Phase	C_6H_5OH	$\frac{Ca(OH)_2}{2}$	Solid Phase
4.82	4.20	1.3	53.19	7.56	1.3
7.65	5.16	"	68.25	4.08	"
11.03	6.12	"	75.25	3.60	" + C_6H_5OH
12.41	6.47	"	74.06	1.38	C_6H_5OH

OH 1.3 = $(C_6H_5O)_2Ca \cdot 3H_2O$.

At concentrations of $Ca(OH)_2$ less than 0.55 mol. per cent two liquid layers having the following composition are formed:

Aqueous layer		Phenol layer	
Mol. % C_6H_5OH	Mol. % $\frac{Ca(OH)_2}{2}$	Mol. % C_6H_5OH	Mol. % $\frac{Ca(OH)_2}{2}$
1.79	0	32.33	0
2.16	0.14	23.08	0.37
2.76	0.23	18.48	0.54

100 gms. of a saturated solution of $Ca(OH)_2$ in Furfural contains 0.13 gms. $Ca(OH)_2$ at 25°. (Trimble, 1941).

PO CALCIUM PHOSPHATE (Tribasic) $Ca_3(PO_4)_2$

SOLUBILITY IN WATER

The determinations of the solubility of this salt in water, as stated in the literature, are found to vary within rather wide limits, due, no doubt, to the fact that so-called tribasic calcium phosphate is apparently a solid solution of the dibasic salt and calcium-oxide, and therefore analyses of individual samples may show an excess of either lime or phosphoric acid. When placed in contact with water, more PO_4^{3-} ions enter solution than Ca^{++} ions, the resulting solution being acid in reaction and the solid phase richer in lime than it was, previous to being added to the water. For material having a composition approximating closely that represented by the formula $Ca_3(PO_4)_2$ the amount which is dissolved by CO_2 -free water at the ordinary temperature, as calculated from the calcium determination, is 0.01 to 0.10 gram per liter, depending upon the conditions of the experiment. Water saturated with CO_2 dissolves 0.15 to 0.30 gram per liter.

A list of references to early papers on this subject is given by Cameron and Hurst--J. Am. Chem. Soc., 26, 903, 1904; see also Cameron and Bell, Ibid., 27, 1512, 1905.

Eisenberger, Lehman and Turner (1940) present a review of the system $CaO - P_2O_5 - H_2O$ and conclude that Tricalcium Phosphate and Hydroxyapatite do not exist in aqueous solutions as unique, stoichiometric compounds, but that a series of solid solutions exists in the ternary system between the compositions $CaHPO_4$ and CaO which have the

SOLUBILITY IN WATER--Cont.

Apatite lattice. The compound $\text{Ca}_3(\text{PO}_4)_2$ thus represents only one point in a continuous range of possible compositions.

Greenwald (1942) determined the solubility of Tri-Calcium Phosphate and found that the apparent solubility product increased with increasing amounts of solid phase present, and also with increasing pH. This is contrary to the findings of Logan and Taylor (1927) and it is shown that the opposite results which was obtained by these authors may have been caused by supersaturation.

Ponomarev, 1921 gives freezing points for aq. $\text{Ca}_3(\text{PO}_4)_2 + \text{Na}_2\text{B}_4\text{O}_7$.

THE SYSTEM TRICALCIUM PHOSPHATE AND WATER AT ABOUT 20°
(Frohlich, 1929; Danneel and Frohlich, 1930)

PO

Accurately weighed amounts of tricalcium phosphate were shaken with amounts of water which varied from 200 parts to 1 part of solid to 50,000 parts to 1 of solid. The filtered solutions were analyzed for CaO and P_2O_5 .

Ratio in gms. $\text{Ca}_3(\text{PO}_4)_2:\text{H}_2\text{O}$	Milligrams per liter		Av. Mgm. mol. per liter		mmol. mmol.
	CaO	P_2O_5	CaO	P_2O_5	
1.0 : 200	60.6-62.3	139.2-143.5	1.095	0.995	1.10
0.2 : 200	21.85	41.23	0.39	0.29	1.34
0.1 : 500	10.10-11.22	11.38-14.21	0.19	0.093	2.04
0.5 : 500	8.42-9.54	8.54-9.95	0.16	0.062	2.58
0.05 : 1000	5.32	5.68	0.095	0.04	2.38
0.033 : 1000	4.82-5.32	4.83-5.27	0.090	0.0356	2.53
0.03 : 1500	3.31-3.98	3.41-3.98	0.067	0.0264	2.54

100 gms. sat. solution of tricalcium phosphate in water contain 0.0059 gm. CaO and 0.0138 gm. P_2O_5 at 25°. (Pauli and Stenzinger, 1929).

THE SOLUBILITY PRODUCT OF SECONDARY AND TERTIARY CALCIUM
PHOSPHATE UNDER VARIOUS CONDITIONS
(Holt, Jr., La Mer and Chown, 1925)

Results are first given by the authors obtained by titrating 0.01 molar H_3PO_4 solution with saturated lime water. They determined the pH ranges over which CaHPO_4 and $\text{Ca}_3(\text{PO}_4)_2$ are stable. The solubility product in terms of activities (i.e. the stoichiometric solubility product at infinite dilution) was found to be $10^{-6.4}$ for CaHPO_4 and $10^{-32.5}$ for $\text{Ca}_3(\text{PO}_4)_2$ at 38°. Data for the effect of salts in solution upon these solubility products are given, and the stoichiometric solubility product constant for $\text{Ca}_3(\text{PO}_4)_2$ in blood serum was found to be 10^{-26} at 38°. In a later paper by Holt (1925) it was shown that tertiary calcium phosphate is far less soluble in cerebrospinal fluid than in blood serum. The data have been recalculated by Holt, Pierce and Kajdi (1954).

Greenwald (1945) shows that the solubility of Tri-Calcium Phosphate is increased by the presence of Bicarbonate ions, and that the solubility of Calcium Phosphate in Sodium Chloride Solutions and in Serum Salt Solutions of the same ionic strength is the same. These findings explain the results of Holt, LaMer, and Chown and of Sendroy and Hastings (above) on the solubility in serum and in salt solutions.

The K_{sp} of $\text{Ca}_3(\text{PO}_4)_2$ is given by Zharovskii (1951) as 2.0×10^{-29} at 18-20°.

THE SOLUBILITY OF TERTIARY CALCIUM PHOSPHATE IN SALT SOLUTIONS
AND IN BIOLOGICAL FLUIDS AT 38°
(Sendroy, Jr., and Hastings, 1926)

In this paper the authors have developed the equations relating the second and the third dissociation constants of phosphoric acid to the ionic strength of the solution. They also give data for the solubility of $\text{Ca}_3(\text{PO}_4)_2$ in salt solutions and in serum. The results are for cases in which only $\text{Ca}_3(\text{PO}_4)_2$ is present as the solid phase and in which salts comparable in amount and kind to those found in serum and transudates were present.

PO SOLUBILITY OF CALCIUM PHOSPHATES IN PHOSPHORIC ACID SOLUTIONS

The data of Bassett, Jr. (1907, 1908, 1917), Elmore and Farr (1940), Belopolski, Serebrennikova and Bilevic (1940), Cameron and Seidell (1905), Flatt, Brunisholz and Chapuis-Gottreux (1951) 25° and Flatt, Brunisholz and Denereaz (1956) 50° are in agreement. Further data are given by Cameron and Bell (1905, 1910) and by Artur (1955).

Data of Bassett, Jr., 1908, 1917

In the case of most of the solutions 7-15 weeks constant agitation was allowed for attainment of equilibrium. For the last seven results at 25°, 18 months were required. Cerasine bottles were used in these cases. The solid phases were determined by analysis. The quintuple points were found by dilatometer experiments at 36°, 21° and 152°. (See next page.)

Results at 25°			Results at 40°--Cont.		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CaO	P ₂ O ₅	Solid Phase	CaO	P ₂ O ₅	Solid Phase
3.088	36.11	$\text{CaH}_4\text{P}_3\text{O}_8 \cdot \text{H}_2\text{O}$	2.536	9.905	CaHPO_4
4.908	28.34	"	1.847	6.979	"
5.809	24.20	" + CaHPO_4	1.267	4.397	"
5.523	22.90	CaHPO_4	0.576	1.819	"
4.499	17.55	"	0.156	0.426	"
2.638	9.100	"	0.0592	0.158	"
1.878	6.049	"	0.0508	0.128	$\text{Ca}_3\text{P}_2\text{O}_8 \cdot \text{H}_2\text{O}$
0.826	2.387	"	0.0098	0.0262	"
0.165	0.417	{ " $\text{CaHPO}_4 \cdot$ 2H ₂ O	0.0709	trace	$\text{Ca}_4\text{P}_2\text{O}_9 \cdot 4\text{H}_2\text{O}$
0.07	0.166		0.0814	"	"
0.06	0.140	"	0.0840	"	"
0.05	0.118	"			
0.04	0.093	"			
0.03	0.070	{ More basic than $\text{CaHPO}_4 \cdot$ 2H ₂ O	0.336	62.01	$\text{CaH}_4\text{P}_2\text{O}_8 + \text{CaH}_4\text{P}_2\text{O}_8 \cdot \text{H}_2\text{O}$
0.02	0.047		0.635	58.08	$\text{CaH}_4\text{P}_2\text{O}_8 \cdot \text{H}_2\text{O}$
0.01	0.023		1.428	50.25	"
			2.974	41.92	"
			4.880	33.18	"
			5.725	29.61	" + CaHPO_4
1.768	42.42	$\text{CaH}_4\text{P}_2\text{O}_8 \cdot \text{H}_2\text{O}$	3.507	15.48	CaHPO_4
3.584	36.79	"	2.328	9.465	"
5.755	27.25	" + CaHPO_4	1.563	6.157	"
4.813	21.67	CaHPO_4	0.692	2.281	"
3.810	16.35	"			

(Contd.)

SOLUBILITY OF CALCIUM PHOSPHATES IN PHOSPHORIC ACID SOLUTIONS--Cont.

Data of Bassett, Jr., 1908, 1917--Cont.

Results at 50.7°--Cont.			Results at 50.7°--Cont.		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaO	P ₂ O ₅		CaO	P ₂ O ₅	
0.0596	0.1527	CaHPO ₄ .2H ₂ O	0.0106	0.0309	Ca ₃ P ₂ O ₆ .H ₂ O
0.0514	0.1331	Ca ₃ P ₂ O ₆ .H ₂ O	0.0007	0.0007	"
0.0351	0.0942	"			

PO

Results at Higher Temperatures

t°	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	CaO	P ₂ O ₅	
100	2.503	53.71	CaH ₄ P ₂ O ₈ + CaH ₄ P ₂ O ₈ .H ₂ O
115 b. pt.	5.623	43.60	CaH ₄ P ₂ O ₈ .H ₂ O + CaHPO ₄
132 "	4.327	53.43	CaH ₄ P ₂ O ₈ + CaH ₄ P ₂ O ₈ .H ₂ O
169 "	4.489	63.95	CaH ₄ P ₂ O ₈
152(dilatometric)	5.60	53	CaH ₄ P ₂ O ₈ + CaH ₄ P ₂ O ₈ .H ₂ O + CaHPO ₄
21(")	5.81	23.5	CaH ₄ P ₂ O ₈ .H ₂ O + CaHPO ₄ + CaHPO ₄ .2H ₂ O
36(")	0.0514	0.14	CaHPO ₄ + CaHPO ₄ .2H ₂ O + Ca ₃ P ₂ O ₆ .H ₂ O

Data of Elmore and Farr, 1940

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CaO	P ₂ O ₅	Density		CaO	P ₂ O ₅	Density	
Results at 25°				Results at 75°--Cont.			
5.785	24.10	1.3018	CaHPO ₄ + Ca(H ₂ PO ₄) ₂ .H ₂ O	4.276	40.18	1.428	Ca(H ₂ PO ₄) ₂ .H ₂ O
3.411	34.94	1.3795	Ca(H ₂ PO ₄) ₂ .H ₂ O	3.964	41.57	1.440	"
2.621	38.53	1.4112	"	3.676	42.71	1.449	"
2.307	39.97	1.4216	"	3.356	44.03	1.461	"
2.008	41.48	1.4360	"	2.986	45.91	1.482	"
1.708	43.05	1.4506	"	2.622	47.72	1.496	"
1.365	45.03	1.4700	"	2.152	50.31	1.526	"
1.064	46.97	....	"	1.731	53.16	1.557	"
0.695	50.26	1.5307	"	1.408	55.97	1.595	"
.475	53.04	1.5676	"	0.999	58.25	1.624	Ca(H ₂ PO ₄) ₂
.320	56.44	1.6143	"	.693	60.68	1.654	"
.249	59.21	1.6549	"	.379	64.96	1.718	"
.201	61.66	1.6932	" + Ca(H ₂ PO ₄) ₂	.267	70.12	1.806	"
.190	62.56	1.7090	Ca(H ₂ PO ₄) ₂				
.090	65.55	1.7522	"				
.051	70.24	....	"			
.054	70.42	1.8406	"				
Results at 75°				Results at 40°			
0.748	3.23	1.007	CaHPO ₄	4.760	21.48	1.2480	CaHPO ₄
1.963	10.14	1.080	"	5.785	26.47	....	CaHPO ₄ + Ca(H ₂ PO ₄) ₂
3.165	16.96	1.159	"	3.922	35.08	....	Ca(H ₂ PO ₄) ₂ .H ₂ O
4.337	23.95	1.246	"	2.825	39.76	1.4206	"
5.387	32.47	1.357	"	1.376	47.55	1.4998	"
4.980	37.21	1.399	Ca(H ₂ PO ₄) ₂ .H ₂ O	1.371	47.69	1.4964	"
				0.923	50.89	1.5400	"
				.737	52.25	1.5604	"
				.621	53.90	1.5823	"
				.441	57.40	1.6338	"

Ca CALCIUM

SOLUBILITY OF CALCIUM PHOSPHATES IN PHOSPHORIC ACID SOLUTIONS--Cont.

Data of Elmore and Farr, 1940--Cont.

	Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
	CaO	P ₂ O ₅	Density		CaO	P ₂ O ₅	Density	
	Results at 40°--Cont.				Results at 100°--Cont.			
PO	0.437	57.64	1.6365	Ca(H ₂ PO ₄) ₂ ·H ₂ O	5.529	40.15	1.432	CaHPO ₄ + Ca(H ₂ PO ₄) ₂ ·H ₂ O
	.414	58.32	1.6376	"	5.432	40.80	1.438	Ca(H ₂ PO ₄) ₂ ·H ₂ O
	.205	62.30	1.6960	" + Ca(H ₂ PO ₄) ₂	5.183	41.67	1.416	"
	.214	61.94	1.6917	"	4.301	45.37	1.476	"
	.195	62.64	1.7016	"	3.411	49.76	1.519	"
	.120	65.76	1.7548	Ca(H ₂ PO ₄) ₂	2.822	52.91	1.554	"
	.084	65.35	1.8206	"	2.719	53.57	1.564	"
					2.479	55.48	1.583	"
	Results at 100°				1.871	57.15	1.599	Ca(H ₂ PO ₄) ₂
	0.871	5.04	1.0143	CaHPO ₄	1.703	58.00	1.610	"
	2.407	14.90	1.107	"	1.489	59.22	1.623	"
	3.958	24.70	1.224	"	1.127	61.48	1.651	"
	4.996	32.89	1.332	"	0.719	65.36	1.708	"
	5.117	33.88	1.342	"	0.584	70.04	1.791	"

Data of Belopolski, Serebrennikova, and Bilevic, 1940

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CaO	P ₂ O ₅	Density		CaO	P ₂ O ₅	Density	
Results at 25°				Results at 50.7°			
2.88	0.86	1.109	CaHPO ₄	2.24	9.70	1.096	CaHPO ₄
4.14	15.29	1.174	"	3.02	13.43	1.137	"
5.34	21.11	1.270	"	3.84	17.98	1.189	"
5.80	24.47	1.298	" + Ca(H ₂ PO ₄) ₂ ·H ₂ O	5.32	26.55	1.299	"
4.51	30.40	1.337	Ca(H ₂ PO ₄) ₂ ·H ₂ O	5.69	29.47	1.334	" + Ca(H ₂ PO ₄) ₂ ·H ₂ O
3.39	35.61	1.375	"	4.33	35.23	1.381	Ca(H ₂ PO ₄) ₂ ·H ₂ O
2.31	40.14	1.419	"	3.28	40.75	1.422	"
1.33	46.39	1.466	"	2.18	45.43	1.464	"
0.92	48.60	1.486	"	1.37	50.61	1.515	"
.50	53.74	...	"	0.83	55.61	1.579	"
.37	55.47	1.570	"				
Results at 80°				Results at 95°			
1.66	9.45	1.066	CaHPO ₄	4.79	30.56	1.308	CaHPO ₄
2.39	13.05	1.112	"	5.32	35.29	1.358	"
3.87	21.85	1.203	"	5.60	40.04	1.422	" + Ca(H ₂ PO ₄) ₂ ·H ₂ O
4.66	27.20	1.276	"	4.21	45.00	1.460	Ca(H ₂ PO ₄) ₂ ·H ₂ O
5.65	36.30	1.382	" + Ca(H ₂ PO ₄) ₂ ·H ₂ O	3.33	49.13	1.512	"
4.37	41.55	1.439	Ca(H ₂ PO ₄) ₂ ·H ₂ O				
3.60	44.98	1.462	"				
2.27	51.96	1.538	"				
1.69	56.54	1.581	"				

SOLUBILITY OF CALCIUM PHOSPHATES IN PHOSPHORIC ACID SOLUTIONS--Cont.

Data of Cameron and Seidell, 1905 at 25°

Grams per Liter of Solution		Solid Phase	Grams per Liter of Solution		Solid Phase
CaO	P ₂ O ₅		CaO	P ₂ O ₅	
1.71	4.69	CaHPO ₄ ·2H ₂ O	77.00	317.0	CaHPO ₄ ·2H ₂ O + CaH ₄ (PO ₄) ₂ ·H ₂ O
11.57	36.14	"	72.30	351.9	CaH ₄ (PO ₄) ₂ ·H ₂ O
23.31	75.95	"	69.33	361.1	"
39.81	139.6	"	59.98	419.7	"
49.76	191.0	"	53.59	451.7	"
59.40	234.6	"	44.52	505.8	"
70.31	297.7	"	39.89	538.3	"

Additional data on the system CaO - H₃PO₄ - H₂O (at 26°) in the presence of Kaolinite and Ferric Oxide are given by Mebane, 1940.

Data for the system CaO + P₂O₅ + HCl + H₂O at 25° and 40° are given by Taperova and Shulgina, 1946.

SOLUBILITY OF CALCIUM PHOSPHATES IN ACIDS AND BASES
(Ghani and Aleem, 1942)

The authors shook 10 mg. of Ca₃(PO₄)₂, Ca(H₂PO₄)₂, CaHPO₄ and Apatite at room temperature for two hours with 0.5 N Acetic Acid, 0.25 N NaOH, and 2N H₂SO₄, and report the milligrams of P₂O₅ dissolved in the volume of solvent used. These figures were recalculated to the form below:

Solvent	Mg. Dissolved in 100 ml.			
	Ca ₃ (PO ₄) ₂	CaHPO ₄	Ca(H ₂ PO ₄) ₂	Apatite
0.5 N CH ₃ COOH	>3.7	>4	>4	2.5
0.25 N NaOH	0.06	0.6	1.4	Trace
2 N H ₂ SO ₄	>4	>4	>4	3.6

Values indicated as >4 mean that the entire sample dissolved in the volume of solvent used.

Devaytin, 1940 determined the solubility of Ca₃(PO₄)₂, CaHPO₄, and Ca(H₂PO₄)₂ in water and in 0.2 and 1.0 NK₂CO₃ solution, cold and at the boiling point.

Data for the solubility of mineral phosphates in aqueous 2% citric acid solutions are given by Aita, 1916. Results for superphosphates are given by Pratolongo, 1916.

Additional data and further discussion of the solubility of tertiary calcium phosphate and of phosphatic slags in aqueous solutions of acids and of salts are given by Aita, 1917, Cirkov, 1918 and Atkins, 1924.

Data for the four component system, lime, phosphoric acid, sulfuric acid and water, the essential constituents of "superphosphates," are given by Cameron and Bell (1906).

The solubilities of various soil phosphates in HCl and NH₃ solutions under various conditions were determined by Fraps, 1911.

Ca CALCIUM

SOLUBILITY OF CALCIUM PHOSPHATES IN ACIDS AND BASES--Cont.

Experiments having for their object the preparation of phosphates of calcium more basic than $\text{Ca}_3(\text{PO}_4)_2$, by Lorah, Tartar and Wood, 1929, showed that by hydrolysis with boiling water and CO_2 free NaOH solutions a final product of the composition $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$ was obtained. Precipitation from alkaline phosphate solutions was tried for the preparation of basic phosphates but no evidence of their existence was obtained. Adsorption experiments were made to ascertain whether there is a reaction between basic calcium phosphate and $\text{Ca}(\text{OH})_2$ but no such reaction was found.

Data for the solubility of natural phosphate rock in water at 15° under pressures of CO_2 up to 5kg. per sq. cm. are given by Campardou, PO 1933.

The solubility of Calcium Phosphate in Sea Water is given by Dietz, Emery and Shepherd, 1942.

Approximate solubilities of $\text{Ca}_3(\text{PO}_4)_2$ in 0.001 - 0.5N HNO_3 were determined by Tananaev, Chrelashvili and Sheliya, 1940.

One liter of aqueous 0.005 N potassium bitartrate solution sat. with calcium phosphate, (?) contains 0.08 gm. Ca and 0.181 gm. H_3PO_4 at 25° . (Magnanini, 1901).

In studies upon the composition of bone, Shear and Kramer, 1928; and Shear, Washburn and Kramer, 1929, point out that previous investigations have shown that the solubility product of $\text{Ca}_3(\text{PO}_4)_2$ is not the quantity which governs the deposition of calcium phosphate, and that the mechanism of bone calcification is still obscure. They believe that if the solubility product of CaHPO_4 be employed instead of that of $\text{Ca}_3(\text{PO}_4)_2$, information regarding calcification may be obtained.

In their experiments they use crystalline CaHPO_4 made by precipitation from solutions of pH not greater than 5.5. They found that with this compound, equilibrium is reached very rapidly. When 0.1 gm. cryst. CaHPO_4 was shaken at room temperature for one hour with 20 cc H_2O , and pH of the solution was 6.9 and there was present 3.6 mgs. Ca and 3.2 mgs. P per 100 cc. These quantities were not increased by longer shaking. Although the ratio of Ca to P varies with the excess of solid phase the ion product $[\text{Ca}^{++}] \times [\text{HPO}_4^{--}]$ at equilibrium, does not. Using ionic strengths of "Inorganic Serum Solutions" made with Na, K, Cl and CO_2 present in the same concentration as in normal blood serum, the authors found the value of K's.p. CaHPO_4 , the solubility product of CaHPO_4 , to be $[\text{Ca}^{++}] \times [\text{HPO}_4^{--}] = 3.2 \pm 1 \times 10^{-6}$ at room temperature and $[\text{Ca}^{++}] \times [\text{HPO}_4^{--}] = 3.4 \pm 1 \times 10^{-6}$ at 38° .

Rae and Clegg (1948) report the solubility of Ca_3PO_4 , tooth enamel and whole teeth in 1% Lactic Acid Solutions, alone and in the presence of added salts. The results are expressed in terms of loss in weight of the starting material, and the mg. of Ca and P in solution. NaF , $(\text{NH}_4)_2\text{C}_2\text{O}_4$, $\text{Pb}(\text{NO}_3)_2$, $\text{Ba}(\text{NO}_3)_2$, AgNO_3 and AgF were used as added salts and the "protective effect" of a second precipitate on the original Calcium Phosphate was studied in 0.01 - 0.05 M solutions, which reduced the solubility of Calcium Phosphate to as little as 1/6 the amount which dissolved in Lactic Acid alone.

Logan and Kane (1939) report on the amounts of Calcium Phosphate in solution in equilibrium with young and old bones and find a decrease with increasing amounts of solid bone added. Some difficulties were encountered because of the protein material which was present. Also see Greenwald (1942).

SOLUBILITY OF CALCIUM PHOSPHATE IN CITRIC ACID SOLUTIONS (Maurice, 1939)

The author gives curves showing the relative solubility of $\text{Ca}_3(\text{PO}_4)_2$ and natural phosphates in various concentrations of Citric Acid (up to 1%). The $\text{Ca}_3(\text{PO}_4)_2$ used was about four times as soluble as the Apatite used, as measured by the P_2O_5 content of the solutions. The solubility of $\text{Ca}_3(\text{PO}_4)_2$ in different volumes of 1% Citric Acid was determined with varying amounts of CaCO_3 added. No temperature is given. The data below were read from the curves.

Gms. CaCO_3 Added per gm. $\text{Ca}_3(\text{PO}_4)_2$	Mg. P_2O_5 per 100 ml. Sat. Sol.	Mg. P_2O_5 per 200 ml. Sat. Sol.	Mg. P_2O_5 per 300 ml. Sat. Sol.	P0
0.0	340	570	800	
.200	225	470	680	
.400	150	400	600	
.600	80	300	500	
.800	60	230	400	
1.000	50	200	340	

The effect of added oxides: Al_2O_3 , SiO_2 , Fe_2O_3 on the solubility of various mixtures of $\text{CaO} + \text{P}_2\text{O}_5$ in Ammonium Citrate Solutions (solubility decreases) was determined by Frear, Deese and Lefforge (1944). It was found that crystalline $\text{CaO} + \text{P}_2\text{O}_5$ samples had a lower solubility than ones which were glass-like. The effect of the added oxides on the hygroscopicity and fusibility was also studied.

The solubility of slags in the system $\text{CaO}.\text{P}_2\text{O}_5.\text{SiO}_2$ in Citric Acid Solutions increases with increasing silicon content. (Willems, 1943).

SOLUBILITY OF CALCIUM PHOSPHATE IN AQUEOUS SALT SOLUTIONS UNDER 2 ATMOSPHERES PRESSURE OF CO_2 AT 14° (Ehlert and Hempel, 1912)

Salt in Aq. Solvent	Gms. Salt per 100 Gms. H ₂ O		Salt in Aq. Solution	Gms. Salt per 100 Gms. H ₂ O	
	Ca ₃ (PO ₄) ₂ per Liter Solvent			Ca ₃ (PO ₄) ₂ per Liter Solvent	
Water	...	0.228	MgSO ₄ .K ₂ SO ₄ .MgCl ₂ .6H ₂ O	70.95	1.777
NH ₄ Cl	45.74	1.371	"	conc.	2.491
"	conc.	1.293	K ₂ SO ₄	74.5	4.904
(NH ₄) ₂ SO ₄	56.5	2.413	"	conc.	4.765
"	conc.	5.885	NaCl	50	1.321
MgCl ₂ .6H ₂ O	86.9	1.287	"	conc.	0.641
"	conc.	2.892	NaNO ₃	72.7	1.583
MgSO ₄ .7H ₂ O	105.3	1.9728	"	conc.	0.864
"	conc.	3.6001	Na ₂ SO ₄ .10H ₂ O	137.7	2.491
MgCl ₂ .KCl.6H ₂ O	79.2	1.577	"	conc.	3.227
"	conc.	1.154			

Data for the solubility of calcium phosphate in aqueous saturated solutions of carbon dioxide containing ammonia are given by Foster and Neville, 1910.

Ca CALCIUM

SOLUBILITY OF CALCIUM PHOSPHATE AND CALCIUM SULFATE AT 75.3° - EQUILIBRIUM IN THE SYSTEM $\text{CaO} - \text{P}_2\text{O}_5 - \text{SO}_3 - \text{H}_2\text{O}$ (Campbell and Coutts, 1948)

The solubility relationships in the system $\text{CaO} + \text{P}_2\text{O}_5 + \text{H}_2\text{O}$ are changed to a very small extent upon the addition of SO_3 . As the concentration of P_2O_5 increases, the solubility of CaSO_4 in the solution becomes negligibly small. The phases were identified by optical examination.

Gms. per 100 gms.
Saturated Solution

PO	CaO	P ₂ O ₅	SO ₃	Solid Phase
0.109	0.294	0.151		$\text{Ca}_3(\text{PO}_4)_2 \cdot \text{H}_2\text{O} + \text{CaHPO}_4 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
.122	.310	.154		"
.118	.283	.157		"
.281	.976	.141		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{CaSO}_4$ (Trace)
.741	3.07	.157		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
2.01	9.49	.125		"
2.68	13.35	.091		"
3.49	18.09	.075		"
3.94	20.93	.081		"
4.92	27.51	.052		"
5.27	30.53	.048		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$
5.37	31.68	...		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
5.45	32.72	.050		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$
5.52	33.54	.035		"
5.64	35.51	.033		$\text{CaHPO}_4 + \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O}$
5.68	35.60	.028		"
5.38	36.54	.035		$\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O} + \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$
5.10	37.60	.026		"
4.35	40.62	.018		"
3.30	44.63	.017		"
2.96	46.00	Trace		"
2.40	49.02	...		"
1.65	54.24	...		"
1.275	57.46	...		$\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O} + \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Ca}(\text{H}_2\text{PO}_4)_2$ (Trace)
1.269	57.38	...		"
1.150	57.47	...		"

For data on the solubility of Calcium Phosphates in Calcium Nitrate solutions look under $\text{Ca}(\text{NO}_3)_2$.

PO CALCIUM PHOSPHATE (Dibasic) $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$

Some data for this salt are also found on pp. 644-651 (above).

SOLUBILITY IN WATER

(Cameron and Seidell, 1904; Rindell, 1902; Magnanini, 1901)

1 liter of CO_2 free water dissolves 0.136 gram CaHPO_4 at 25°.

1 liter of water sat. with CO_2 dissolves 0.561 gram CaHPO_4 at 25°.

THE SOLUBILITY OF DICALCIUM PHOSPHATE ($\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$) IN WATER AND
IN AQUEOUS SOLUTIONS AT $18-22^\circ$
(Domontovitch and Sarubina, 1925)

The determinations were made by precipitation and by solution experiments. The precipitation experiments were made by mixing, in different proportions, a 0.1 mol. solution of CaCl_2 , a 0.1 mol. solution of KH_2PO_4 and a 0.2 mol. solution of NaOH . The mixtures were allowed to stand at room temperature ($19-22^\circ$) for a long time and shaken daily. The Ca, P_2O_5 and pH were determined. In the case of the solution experiments 1 gram per liter of freshly precipitated $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ (made by 2 different methods) was placed in a series of different solvents and stirred by drawing purified air through the mixtures for six hours daily. The solutions were analyzed after 1, 2, 3 and 4 weeks. PO

Original composition of the solvent		Composition of the saturated solution				Total ion concentration
		Millimols per liter		Ca P ₂ O ₅	pH	
		Ca	P ₂ O ₅			
	Water	0.723	0.514	1.410	7.15	0.0017
	"	0.798	0.451	1.770	7.24	0.0017
0.001	molar CH ₃ COOH	1.398	0.704	1.980	6.46	0.0028
0.003	" "	2.993	1.550	1.930	5.71	0.006
0.005	" "	3.890	2.110	1.850	5.40	0.008
0.010	" "	7.083	3.591	1.970	4.95	0.014
0.005	" H ₃ PO ₄	5.340	5.490	0.970	5.00	0.016
0.025	"	2.690	2.890	0.956	5.60	0.008
0.003	" Succinic Acid	4.690	2.465	1.870	5.42	0.010
0.004	" HCl	3.990	2.324	1.720	5.41	0.013
0.004	" HCl + 0.044 mol. NaCl ..	4.390	2.395	1.840	5.62	0.10
"	" " + " " ..	4.190	2.392	1.750	5.67	0.10
0.016	" " + 0.026 " " ..	15.960	8.591	1.860	4.53	0.10
"	" " " " " " ..	15.760	8.591	1.840	4.57	0.10
0.08	" " 0.038 " " ..	8.180	4.295	1.920	5.07	0.10
"	" " " " " " ..	7.981	4.295	1.860	5.13	0.10
0.05	" NaCl	1.400	0.732	1.910	7.24	0.10
0.10	" "	1.600	0.916	1.750	7.22	0.20
0.034	" CaCl ₂	34.70	0.672	51.600	5.71	0.10
0.005	" KH ₂ PO ₄	0.648	5.920	0.110	5.89	0.017
"	"	1.100	24.00	0.045	5.30	0.10
0.0025	" ($\frac{8}{10}$ Na ₂ HPO ₄ + $\frac{2}{10}$ NaH ₂ PO ₄) ..	0.299	2.250	0.133	6.86	0.008
0.005	" " " " " " ..	0.249	3.940	0.063	6.80	0.015

The solubility product ($\text{Ca}^{++})(\text{HPO}_4^{--})$ was $10^{-6.25}$ for distilled H_2O (not free of CO_2) at $19-22^\circ$. With smaller electrolytic concentration the value of the solubility product varied between the limits $10^{-6.25}$ and $10^{-5.75}$.

Ca CALCIUM

SOLUBILITY OF DICALCIUM PHOSPHATE (BRUSHITE, $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$) IN
AQUEOUS SALT SOLUTIONS AT 40°
(Lugg, 1931)

Salt	Gm. mols. per liter			Salt	Gm. mols. per liter		
	Salt	Ca	Total P		Salt	Ca	Total P
None*	0.0	0.00241	0.00500	KCl	0.10	0.00401	0.00826
" *	0.0	0.00250	0.00672	"	0.40	0.00548	0.00904
" *	0.0	0.00332	0.00852	"	1.00	0.00688	0.01160
NaCl	0.04	0.00252	0.00490	Na_2SO_4	0.095	0.00492	0.00977
PO	"	0.10	0.00311	"	0.190	0.00597	0.01110
	"	0.20	0.00388	"	0.381	0.00769	0.01290
	"	0.40	0.00516	MgSO_4	0.018	0.00507	0.00476
	"	0.80	0.00641	"	0.045	0.00780	0.00630
	"	1.00	0.00711	"	0.089	0.01350	0.00778

The pH of the solutions varied between 5.36 and 6.06.

*In the case of the results for water alone, 1 gm. of brushite per 50 cc of water and one days shaking in the first case, 3 gms. and 7 days shaking in the second and 3 gms. of more coarsely crystalline preparation and three days shaking in the third. For all the other experiments one gram of brushite and two days shaking was employed.

COMPOSITION OF SOLUTIONS SATURATED WITH DIBASIC CALCIUM PHOSPHATES
(Results of d'Ans and Knutter, 1953 at 25°)

Solid Phase $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$				Solid Phase CaHPO_4		Solid Phase Apatite	
moles per liter		moles per liter		moles per liter		moles per liter	
Ca	PO_4	Ca	PO_4	Ca	PO_4	Ca	PO_4
0.0120	0.0237	0.005	0.0107	0.0115	0.0235	0.00310	0.00608
.0115	.0223	.0045	.0089	.0108	.0218	.00283	.00549
.0097	.0199	.0027	.0049	.0098	.0196	.00236	.00480
.0090	.0177	.0023	.0036	.0087	.0174	.00162	.00324
.0088	.0173	.0017	.0033	.0089	.0172	.00100	.00269
.0074	.0148	.0018	.0030	.0068	.0133	.00103	.00245
.0073	.0146	.00079	.00076	.0051	.0097	.00086	.00215
.0067	.0131					.00062	.00186
						.00023	.00122

(Results of Chepelevetskii, Bol'ts, Vasilenko and Ribinova, 1955 at 40°)

Solid Phase $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$				Solid Phase CaHPO_4			
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
CaO	P_2O_5	CaO	P_2O_5	CaO	P_2O_5	CaO	P_2O_5
1.08	3.27	1.82	4.80	2.88	8.93	2.82	11.57
1.21	3.66	1.91	5.80	2.85	9.03	3.01	12.48
1.46	4.19	2.10	6.42	2.94	9.37	3.17	13.37
1.45	4.24	2.10	6.45	3.48	10.73	3.58	14.66

(Cont.)

COMPOSITION OF SOLUTIONS SATURATED WITH DIBASIC CALCIUM PHOSPHATES--Cont.

(Results of Chepelevetskii, Bol'ts, Vasilenko and Rubinova, 1955 at 40°)--Cont.

Solid Phase $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$						Solid Phase CaHPO_4	
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
CaO	P ₂ O ₅	CaO	P ₂ O ₅	CaO	P ₂ O ₅	CaO	P ₂ O ₅
1.48	4.48	2.33	7.31	3.48	11.23	3.57	14.85
1.65	4.89	2.33	7.32	3.91	12.86	3.54	14.93
1.84	5.74	2.39	7.37	3.91	12.74		
		2.75	8.70	4.52	14.83		

Data for the rate of solution of apatite in H_2SO_4 - H_2O solutions at 50°, 70° and 90° are given by Bratskus and Chepelevetskii, 1950.

SOLUBILITY OF HYDROXYAPATITE $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$

At 24°, a solution of ionic strength = 0.165 (NaCl) at pH 7.0 contains 0.000123 M Ca^{++} and 0.0000711 M $\text{PO}_4^{=}$ when saturated with hydroxyapatite. (Levinskas and Neuman, 1955).

At 18°, pH 7.0 the k_{sp} of pure hydroxyapatite is 2.6×10^{-45} .
 " 40°, pH 7.4 " " " " " " 2.3×10^{-41} .

(Hayek, Mullner and Koller, 1951)

Klement and Weber, 1941 determined the solubility of Hydroxyapatite $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ in water and aqueous solutions at 25°.

A review of the various solubility determinations is given by Hodge, 1951.

THE SYSTEM $\text{CaO} - \text{MgO} - \text{P}_2\text{O}_5 - \text{H}_2\text{O}$
 (Belopol'skii, Shpunt and Shulgina, 1953, 1954, 1954a)

Further data are given by the authors at these temperatures and at 10°, 58° and 130°.

25° Wt. %			50° Wt. %			80° Wt. %			Solid Phase
MgO	CaO	P ₂ O ₅	MgO	CaO	P ₂ O ₅	MgO	CaO	P ₂ O ₅	
7.8	0.7	32.8	8.6	0.6	37.3	..	..	...	A,B,C
7.7	0.9	32.3	8.4	0.8	36.5	10.6	45.0	0.7	A,D,C
4.1	0.04	52.4	7.0	0.3	43.3	..	..	...	A,B,E
3.0	0.1	59.0	3.6	0.2	56.8	5.8	55.4	0.3	A,E,F
0.7	0.1	2.8	1.2	0.3	5.6	1.8	7.1	0.1	C,D
3.7	0.7	14.3	3.1	0.7	13.0	4.4	16.6	0.3	C,D
6.5	0.9	24.7	7.5	0.7	31.6	9.2	36.9	0.4	C,D
5.6	0.3	39.6	7.9	0.5	39.7	..	..	...	A,B
3.2	0.1	58.0	5.0	0.20	53.0	7.6	49.8	0.3	A,E
(Cont.)			(Cont.)			(Cont.)			
A = $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O}$			C = $\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$			E = $\text{Mg}(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$			
B = $\text{Mg}(\text{H}_2\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$			D = CaHPO_4			F = $\text{Mg}(\text{H}_2\text{PO}_4)_2$			

Ca CALCIUM

SHE SYSTEM $\text{CaO} - \text{MgO} - \text{P}_2\text{O}_5 - \text{H}_2\text{O}$ —Cont.

25° Wt. %			50° Wt. %			80° Wt. %			Solid Phase
MgO	CaO	P ₂ O ₅	MgO	CaO	P ₂ O ₅	MgO	CaO	P ₂ O ₅	
1.0	0.2	63.0	1.4	0.3	62.4	4.2	59.2	0.2	A, F
0.0	5.8	24.2	0.0	5.7	29.6	2.1	37.8	4.2	A, D
2.0	4.8	24.5	1.7	4.4	31.1	5.0	40.1	1.9	A, D
4.2	3.2	26.5	3.4	3.1	32.6	8.2	43.6	1.1	A, D
6.8	1.6	30.3	5.7	1.9	34.4	9.3	44.5	0.9	A, D
						10.7	45.0	0.6	A, E, C

PC

A = $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O}$ C = $\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$ E = $\text{Mg}(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$ B = $\text{Mg}(\text{H}_2\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$ D = CaHPO_4 F = $\text{Mg}(\text{H}_2\text{PO}_4)_2$

Data are given for the following systems:

 $\text{Ca}(\text{H}_2\text{PO}_4)_2 + \text{NH}_4\text{H}_2\text{PO}_4 + \text{H}_3\text{PO}_4 + \text{H}_2\text{O}$ at 25° (Flatt, Brunisholz and Chapuis-Gottreux, 1951a) $\text{Ca}(\text{H}_2\text{PO}_4)_2$ in solutions of $\text{Ca}(\text{NO}_3)_2 + \text{NH}_4\text{NO}_3 + \text{HNO}_3$ at 25° (Flatt, Brunisholz and Clere, 1951) $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{NH}_4\text{H}_2\text{PO}_4 + \text{H}^+ + \text{NO}_3^-$ at 25° (Flatt, Brunisholz and Lauber, 1953).SOLUBILITY OF CALCIUM PHOSPHATES IN AQUEOUS SOLUTIONS OF SULFUR DIOXIDE
(Mebane, Dobbins and Cameron, 1929)

The mixtures composed of aqueous phosphoric acid solutions and excess of calcium phosphate and calcium carbonate were stirred by means of a stream of sulfur dioxide. The time required for attainment of equilibrium was two to six weeks. Considerable difficulty was experienced in identifying the solid phases.

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CaO	P ₂ O ₅	SO ₂		CaO	P ₂ O ₅	SO ₂	
Results at 0°				Results at 25°--Cont.			
0.03	0.0	4.03	Ca Sulfite	2.11	3.28	1.60	Ca Sulfite
1.42	0.67	0.43	" + solid sol.				" + solid sol.
1.72	1.23	1.22	" "	2.62	1.10	2.18	" "
2.31	1.58	2.09	" "	3.00	3.80	4.45	" "
2.40	1.63	2.36	" "	4.34	5.94	7.18	" "
2.50	1.91	2.75	" "	5.40	6.11	2.75	" "
4.85	3.29	7.00	" "	5.57	5.86	4.00	" "
4.55	6.08	7.63	Di calcium + mono calcium phosphate	6.08	7.68	2.10	Di calcium and mono calcium phosphate
6.43	13.73	2.13	"				
6.46	13.52	1.48	"	5.54	9.34	1.30	"
				5.22	10.64	1.45	"
				5.52	11.62	0.35	"
1.92	0.0	4.57	Ca Sulfite	6.12	11.45	0.40	"
1.27	1.30	1.60	" + solid sol.	6.25	16.93	2.57	"
1.57	1.63	2.83	" "	6.75	18.11	2.20	"

(Cont.)

SOLUBILITY OF CALCIUM PHOSPHATES IN AQUEOUS SOLUTIONS
OF SULFUR DIOXIDE—Cont.

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CaO	P ₂ O ₅	SO ₂		CaO	P ₂ O ₅	SO ₂	
Results at 25°--Cont.							
6.25	22.01	0.40	Di calcium and mono calcium phosphate	6.20	29.24	0.0	Mono calcium phosphate
5.76	37.77	0.0	Mono calcium phosphate	5.64	33.78	0.0	"
				5.57	36.80	0.0	"

PG

It is stated that the results can not have absolute value, but show only the order of magnitude and that sulfur dioxide has a maximum solubility in contact with the pairs of solid phases. It is concluded that the commercial conversion of phosphate rock to "super" phosphate by means of sulfur dioxide is impractical.

CALCIUM PHOSPHATE monobasic $\text{Ca}(\text{H}_2\text{PO}_4)_2$ (See also preceding pages)

THE SOLUBILITY OF MONO CALCIUM PHOSPHATE IN WATER
(Stollenwerk, 1926)

In seeking to explain the variations in the solubility of mono calcium phosphate, reported by different persons, evidence was obtained, by means of specific gravity determinations upon samples of mono calcium phosphate heated to different temperatures, that isomeric forms exist. This isomerism was studied by vapor tension measurements and the variation in combining powers of different modifications for a given substance, such as ammonia. It was concluded that the present case is a hydrate isomerism resulting from the forcing of water molecules by warming into the interior of the entire molecule. This enlarges the structure and furnishes additional points of attachment for ammonia molecules.

For the purpose of learning the best conditions for the recrystallization of Mono Calcium Phosphate, Clark, 1931, prepared mixtures corresponding to chosen points on the diagram drawn from the results of Bassett, Jr. 1908, and evaporated these solutions at fixed temperatures. The liquids in contact with the crystals thus obtained were analyzed, and the results found to fall upon the isotherms for the particular temperature of the experiment.

Experiments showing the ratio of monocalcium phosphate decomposed at increasing concentrations of the salt in water at 20°, are given by Sanfourche and Focet, 1933.

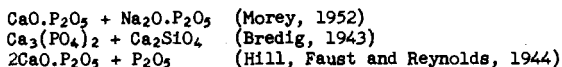
Data for the composition of solutions simultaneously saturated with $\text{Ca}(\text{H}_2\text{PO}_4)_2$, NH_4Cl and $\text{NH}_4\text{H}_2\text{PO}_4$ at 25° are given by Flatt, Brunisholz and Cherc, 1952.

Melting point data are given for the following:

$3\text{CaO} \cdot \text{P}_2\text{O}_5 + 3\text{CaO} \cdot \text{SiO}_2$ (Toropov, Borisenko and Shirokova, 1953)
 $3\text{CaO} \cdot \text{P}_2\text{O}_5 + 2\text{MgO} \cdot \text{SiO}_2$ (Bobrownicki and Swiecki, 1955)
 $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2 + 2\text{MgO} \cdot \text{SiO}_2$ (Bobrownicki and Swiecki, 1955)
 $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2 + \text{MgO} \cdot \text{SiO}_2$ (" ")

Ca CALCIUM

Melting point data are given for the following--Cont.:



CALCIUM Mono Fluoro PHOSPHATE $\text{CaPO}_3\text{F} \cdot 2\text{H}_2\text{O}$

One liter saturated solution in water contains 0.063 gm. mols. CaPO_3F at 20° . (Lange, 1929).

PO CALCIUM ALKYL PHOSPHATES

SOLUBILITY OF EACH IN WATER (Bailly, 1919)

Compound	Formula	t°	Gms. per 100 gms. sat. sol.	
			Anhydrous compound	Hydrated compound
Calcium allyl phosphate	$\text{Ca} \cdot \text{CH}_2 \cdot \text{CHCH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$	20	...	0.28
" iso butyl "	$\text{Ca} \cdot \text{CH}_2 \cdot \text{CH}(\text{CH}_3)_2 \cdot \text{PO}_4 \cdot 2\text{H}_2\text{O}$	18	...	0.19
" ethyl "	$\text{Ca} \cdot \text{C}_2\text{H}_5\text{PO}_4 \cdot 2\text{H}_2\text{O}$	28	...	0.235
" methyl "(neutral)	$\text{Ca} \cdot \text{CH}_3\text{PO}_4 \cdot 2\text{H}_2\text{O}$	10	0.21	0.27
" " "(acid)	$\text{Ca} \cdot \text{CH}_3\text{H} \cdot \text{PO}_4$	17	27.42	...
" propyl "	$\text{Ca} \cdot \text{C}_3\text{H}_7 \cdot \text{PO}_4 \cdot 2\text{H}_2\text{O}$	18.5	...	0.251
" iso propyl "	$\text{Ca} \cdot \text{CH}(\text{CH}_3)_2 \cdot \text{PO}_4 \cdot 2\text{H}_2\text{O}$	24	...	0.09

CALCIUM GLYCEROPHOSPHATES α and β



SOLUBILITY OF CALCIUM GLYCEROPHOSPHATES IN WATER

Results varying from 1.7 to 5.4 gms. per 100 gms. sat. solution at or near 18° are given by Rogier and Fiore (1913), Willstaetter (1904) and King and Pyman (1914). It is pointed out by Couch (1917), however, that since the solubilities of the α and β isomer differ, and also that the commercial product contains both isomers, variable results will be obtained, depending on the composition of the product and the method used for determining the solubility. These authors also show that increasing amounts of alcohol in the solvent decrease the solubility of calcium glycerophosphate.

SOLUBILITY OF CALCIUM α GLYCEROPHOSPHATE IN WATER (Power and Tutin, 1905; Couch, 1917)

t°	Gms. $\text{CaC}_3\text{H}_7\text{O}_6\text{P}$ per 100 Gms. Sat. Sol.	t°	Gms. $\text{CaC}_3\text{H}_7\text{O}_6\text{P}$ per 100 Gms. Sat. Sol.
10	5.0	40	3.5
20	4.6	60	2.7
20	5.2*	80	1.8
25	5.0	100	0.9

*100 grams H_2O dissolve 1.66 grams calcium β glycerophosphate at 20° . (Couch, 1917). The results of King and Pyman (1914) are: 1.4 gms. at 13° and 1 gm. at 15° .

SOLUBILITY OF CALCIUM GLYCEROPHOSPHATE IN WATER--Cont.

(Results of Bailly, 1919)

Name of Compound	Formula		Gms. anhydrous compd. per 100 gms. sat. sol.
Calcium glycono phosphate	$\text{CaC}_3\text{H}_7\text{O}_2 \cdot \text{PO}_4 \cdot \text{H}_2\text{O}$	16	4.88
" " " (amorphous)	$\text{CaC}_3\text{H}_7\text{O}_2 \cdot \text{PO}_4 \cdot \text{H}_2\text{O}$	14	5.00
" " " "	"	16	4.91
" " " "	"	20	3.63
" " " "	"	75	1.29
" " " (crystalline)	"	14	3.95
" " " "	"	18	1.70
" " " "	"	20	1.36
" " " (anhydrous)	$\text{CaC}_3\text{H}_7\text{O}_2 \cdot \text{PO}_4$	18	0.99
" " " "	"	12	1.15
" " " (hydrated)	$\text{CaC}_3\text{H}_7\text{O}_2 \cdot \text{PO}_4 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	18	1.16
" " " "	"	12	1.31
" " " (crystalline)	$\text{CaC}_3\text{H}_5(\text{OH})_2 \cdot \text{PO}_4 \cdot \text{H}_2\text{O}$	14	4.95
" " " (neutral)	$\text{CaC}_2\text{H}_4(\text{OH}) \cdot \text{PO}_4 \cdot \text{H}_2\text{O}$	16	0.30*
" " " (acid)	$\text{Ca}(\text{H} \cdot \text{C}_2\text{H}_4(\text{OH}) \cdot \text{PO}_4)_2$	16	3.99*

PO

*Determination by Bailly and Gaume, 1924.

100 gms. H_2O dissolve 1.0 gm. calcium glycerophosphate at 0° , 1.68 gm. at 16° and 0.43 gm. at 60° . (H. Rogier, These, Paris, 1912).

100 gms. glycerol ($d = 1.2326 = 86.5\%$) dissolve 4.15 gms. calcium glycono phosphate at 20° .

100 gms. glycerol ($d = 1.2645 = 98.5\%$) dissolve 3.98 gms. calcium glycono phosphate at 20° . (Holm, 1921, 1922).

CALCIUM SULFIDE CaS

S

SOLUBILITY OF CALCIUM SULFIDE IN WATER IN THE ABSENCE OF AIR
(Foerster and Kubel, 1924)

The sample was prepared by heating calcium sulfite for 1 hour at $700-750^\circ$. It contained 12.1% CaS.

t°	Minutes digested with H_2O	Gms. sample digested per 100 gms. H_2O	Gms. CaS dissolved per 100 cc. sat. sol.	Per cent of the used CaS dissolved
15	15	2.5414	0.0090	2.9
15	15	2.3759	0.0100	3.5
15	60	2.4707	0.0121	4.0
100	15	3.2079	0.1450	37.4
100	60	5.3080	0.4614	71.8

SOLUBILITY OF CALCIUM SULFIDE IN WATER AND IN AQUEOUS
SOLUTIONS OF HYDROGEN SULFIDE AT 20°
(Riesenfeld and Feld, 1921)

The sample of calcium sulfide contained CaSO_4 , CaO and C. Water saturated with the sample at 20° contained 0.2120 gms. CaS, 0.3881 gms. CaSO_4 and 0.1786 gm. CaO per liter. For the solubility in presence of H_2S an apparatus constructed entirely of glass was used. The air was

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFIDE IN WATER AND IN AQUEOUS
SOLUTIONS OF HYDROGEN SULFIDE AT 20°--Cont.

completely displaced with H_2S to insure that only this gas was present. The equilibrium was approached from below and from above by changing the pressure of the H_2S . The influence of time upon the attainment of equilibrium was found to be considerable, but the rate was shown to be a reaction of the first order and from it the final equilibrium could be estimated. The manometer was read in the beginning and after the solution had been shaken and from this it was known whether equilibrium was being approached from above or below. The results of the analyses in grams of S per 100 cc. were plotted and from the curves and the calculations from Henry's law on the proportion of the S in the form of H_2S , the difference gave that present as calcium sulphhydrate and calcium sulfide.

Pressure of H_2S in mm. Hg	Gms. $Ca(HS)_2$ per 100 cc. sat. sol. at			Pressure of H_2S in mm. Hg	Gms. $Ca(HS)_2$ per 100 cc. sat. sol. at		
	0°	20°	40°		0°	20°	40°
100	26.61	24.87	21.97	500	31.17	28.76	26.61
150	28.76	25.78	23.47	550	31.42	29.09	27.02
200	29.45	26.19	24.24	600	31.66	29.43	27.35
250	29.92	26.86	24.79	650	31.83	29.65	27.69
300	30.09	27.45	25.20	700	32.08	30.09	28.04
350	30.43	27.69	25.50	750	32.33	30.34	28.35
400	30.67	28.10	25.94	760	32.41	30.42	28.44
450	30.92	28.31	26.25				

From the result at 20° and 760 mm. pressure it was calculated that 206.5 gms. of CaS are present per liter. The corresponding figure for CaS in H_2O alone at 20° and 760-mm. pressure of air is 0.212 gms. per liter. Hence H_2S increases the solubility of CaS in water almost 1000 times.

SOLUBILITY OF CALCIUM SULFIDE IN AQUEOUS SUGAR SOLUTIONS
(Stolle, 1900)

Per cent Concentration of Sugar Solutions	Grams CaS Dissolved per Liter of the Sugar Solutions at:						
	30°	40°	50°	60°	70°	80°	90°
0	1.982	2.123	1.235	1.390	1.696	2.032	2.496
10	1.866	1.316	1.441	1.673	1.560	1.634	1.544
20	2.187	1.696	1.802	1.905	1.879	1.892	1.930
27	2.522	2.097	2.059	2.226	2.342	2.304	2.357
35	2.689	2.265	2.304	2.406	2.342	2.857	2.947
42	2.342	2.136	2.226	2.522	2.574	2.509	2.689
49	2.445	2.290	2.458	2.638	2.728	2.818	3.063
55	2.509	2.226	2.340	2.822	2.766	2.972	3.616

Melting points have been determined for:

$CaS + FeS$ Heumann (1942), Vogel and Heumann (1941).
 $CaS + Fe$ Vogel and Heumann (1941).

50 CALCIUM SULFITE CaSO_3 SOLUBILITY IN WATER AND IN AQUEOUS SUGAR SOLUTIONS AT 18°
(Weisberg, 1896)

Solvent	Grams CaSO_3 per 100 cc. Solution	
	At 18°	After Boiling Solution 2 Hours
Water	0.0043	....
10 Per cent Sugar	0.0083	0.0066
30 Per cent Sugar	0.0080	0.0069

S

Results at Higher Temperatures
(Van der Linden, 1916)

Solvent	Gms. $\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$ per 1000 gms. Sat. Solution at:							
	30°	40°	50°	60°	70°	80°	90°	b.pt.
Water	0.064	0.063	0.057	0.061	0.045	0.031	0.027	0.011
Aq. Sucrose of 15 gms. per 100 cc.	0.103	0.083	0.073	0.080	0.059	0.041	0.036	0.041
Aq. Sucrose, 15 gms. + 1.5 gms. Glucose per 100 cc.	0.104	0.081	0.085	0.071	0.060	0.047	0.040	0.029
Water + Excess CaSO_4	0.031	0.029	0.025	0.019	0.012	0.009	0.008	0.006
Aq. Sucrose, 15 gms. per 100 cc. + Excess CaSO_4	0.035	0.032	0.022	0.019	0.021	0.017	0.020	0.021
Aq. Sucrose, 15 gms. + 1.5 gms. Glucose per 100 cc. + Excess CaSO_4	0.032	0.027	0.022	0.020	0.019	0.019	0.019	0.023

EQUILIBRIUM IN THE SYSTEM CALCIUM OXIDE, SULFUR DIOXIDE AND WATER
(Conrad and Benschlein, 1934)Solid phase in all cases was $\text{CaSO}_3 \cdot \frac{1}{2}\text{H}_2\text{O}$.

The author's figures for combined SO_2 have been calculated to CaSO_3 .
A few determinations of sulfate indicated that oxidation of SO_2 to SO_3
during the solubility determinations was negligible.

Total pressure in mm.Hg.	Results at 15°			Results at 25°		
	Gms. per 100 gms. H_2O			Gms. per 100 gms. H_2O		
	Total SO_2	Free SO_2	CaSO_3	Total SO_2	Free SO_2	CaSO_3
50	4.1	2.2	3.56	2.7	1.4	2.44
100	6.8	3.9	5.44	4.7	2.6	3.94
150	8.6	5.1	6.56	6.2	3.6	4.87
200	9.8	5.9	7.31	7.3	4.4	5.44
250	10.9	6.7	7.87	8.3	5.2	5.80
300	11.8	7.4	8.25	9.1	5.7	6.38
350	12.8	8.1	8.81	9.9	6.3	6.75
400	13.8	8.9	9.19	10.6	6.8	7.12
450	14.7	9.6	9.56	11.3	7.3	7.50
500	15.5	10.2	9.94	12.0	7.8	7.87
550	16.3	10.9	10.13	12.7	8.3	8.25
600	17.1	11.5	10.50	13.3	8.7	8.61

(Cont.)

(Cont.)

Ca CALCIUM

EQUILIBRIUM IN THE SYSTEM CALCIUM OXIDE, SULFUR DIOXIDE AND WATER—Cont.

Total pressure in mm Hg.	Results at 15° Gms. per 100 gms. H ₂ O			Results at 25° Gms. per 100 gms. H ₂ O		
	Total SO ₂	Free SO ₂	CaSO ₃	Total SO ₂	Free SO ₂	CaSO ₃
650	17.8	12.1	10.69	14.0	9.2	9.00
700	18.4	12.6	10.87	14.6	9.7	9.19
750	19.1	13.2	11.06	15.2	10.2	9.38
(761)	(12.02)	(7.99)	(7.55)	(at 35°)		

SO CALCIUM SULFATE CaSO₄

SOLUBILITY OF THE DIHYDRATE CaSO₄·2H₂O IN WATER (Hulett and Allen, 1902)

For references to other determinations see Hulett and Allen, also Euler, 1904. For data by the electrolytic conductivity method, see Holleman, Kohlrausch and Rose, 1893, 1908.

t°	Gms. CaSO ₄ per 100 cc. Solution	Millimols per Liter	Density of Solutions
0	0.1759	12.926	1.00197
10	0.1928	14.177	1.00173
18	0.2016	14.817	1.00059
25	0.2080	15.295	0.99911
30	0.2090	15.361	0.99789
35	0.2096	15.405	0.99612
40	0.2097	15.413	0.99439
55	0.2009	14.765	0.98796
65.3	0.1932	14.200	0.98256
75	0.1847	13.575	0.97772
100	0.1619	11.900	.....
107	.....	11.390	.....

SOLUBILITY OF THE HEMIHYDRATE CaSO₄·½H₂O AND ANHYDROUS CaSO₄ IN WATER (Chassevent, 1926, Sborgi and Bianchi, 1940; Hill, 1937)

In Chassevent's work the anhydrite was prepared by boiling a suspension of gypsum in 20% sulfuric acid for three days. It corresponded in properties with natural anhydrite. About 10-20 gm. portions of it were rotated with 250 cc. portions of solvent in closed bottles for periods up to 5 months. Equilibrium was approached both from above and below.

Sborgi and Bianchi determined the concentrations conductimetrically and the results are in fairly good agreement with those of Chassevent.

In Hill's work the saturated solutions were prepared by actively agitating with water, calcium sulfate previously heated to a temperature above 300°. The solutions were filtered before crystallization of the dihydrate. Since this crystallization occurs more rapidly at the lower temperatures, these results are the less accurate. When plotted, the results show the transition CaSO₄·2H₂O → CaSO₄·½H₂O to occur at 42°.

SOLUBILITY OF THE HEMIHYDRATE $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ AND
ANHYDRITE CaSO_4 IN WATER--Cont.

Solid Phase $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$				Solid Phase CaSO_4			
(Chassevent)		(Sborgi and Bianchi)		(Hill)		(Sborgi and Bianchi)	
Gms. CaSO_4 per 100 gms. sat. sol.		Gms. CaSO_4 per 100 gms. sat. sol.		Gms. CaSO_4 per 100 gms. sat. sol.		Gms. CaSO_4 per 100 gms. sat. sol.	
t°		t°		t°		t°	
20	0.298	0	(1.23)	0.9	0.956	5	1.05
25	0.274	5	1.10	5.2	0.946	18	0.72
35	0.242	10	(0.98)	14.5	0.924	25	0.63
45	0.201	15	(0.88)	21.7	0.811	35	0.534
65	0.136	18	0.82	29.3	0.688	40	0.48
75	0.114	25	0.71	34.5	0.640	50	0.41
100	0.067	35	0.603	42.4	0.555	75	0.266
		40	0.550	44.8	0.523	100	0.151
		50	0.47	60.	0.389	110	0.139
		75	0.29	70.5	0.336		
		100	0.189	79.5	0.286		
		110	0.151	81	0.272		
				95.5	0.213		
				96.5	0.201		

() = Interpolated.

Sborgi and Bianchi also give data for the solubility of CaSO_4 in the form of the "Soluble Anhydrite," which solubility parallels that of the hemihydrate, but is smaller at all temperatures. However, when the authors tested the effect of the time and temperature of dehydration on the solubility of Anhydrite (containing analytically 0.01 - 0.02% H_2O) they found the solubility of their product to be 0.840% at 20° [method not given] regardless of the conditions used during dehydration. This results agrees with the solubility found by Chavassent and the authors for $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM SULFATE IN WATER AT TEMPERATURES ABOVE 100°
(Partridge and White, 1929)

Above 100° the only stable phase of calcium sulfate is anhydrite. The transition temperature of gypsum into anhydrite is at 42° . Hemihydrate is the only other form of calcium sulfate which has existence in the range 0° to 200° . So-called "soluble anhydrite" is identical in crystal form with hemi-hydrate and the solubility curve formerly given as that of "soluble anhydrite" is a prolongation of and coincides above 100° with the curve for hemi-hydrate. Hemi-hydrate is metastable for periods up to 48 hours in the approximate range 90° - 130° being increasingly unstable below and above this range. The trans. temp. of gypsum to hemi-hydrate is at 98° . Incomplete experiments indicate that gypsum is converted to hemi-hydrate in less than one day in contact with water at 100° , and that the hemi-hydrate is subsequently transformed into anhydrite over longer periods of time.

The data of Straub (1932) for anhydrite are in good agreement. The determinations were made in small steel bombs. Equilibrium was reached in 6 to 10 hours. The analyses of the solutions showed in each case a smaller number of millimols of SO_4 than of Ca. The explanation is considered to be that a small amount of $\text{Fe}(\text{OH})\text{SO}_4$ was formed by reaction

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN WATER AT TEMPERATURES ABOVE 100°--Cont.

with the bomb at the high temperatures. The data, based on the calcium analysis, are given in the table below. Booth and Bidwell (1950) extended the observations to 400° and drew a smooth curve through all the various data. The results (B. & B.) below were read from the curve.

Solutions Saturated with Hemihydrate $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$			Solutions saturated with Anhydrite CaSO_4			
30	t°	Gms. CaSO_4 per 100 gms. sat. sol.	t°	Gms. CaSO_4 per 100 gms. sat. sol.		
				P. & W.	B. & B.	S.
	100		100	0.0650	....	....
	110		110	0.0535	....	....
	120	0.1645	120	0.0435	....	....
	130	0.1290	130	0.0350	....	....
	140	0.1030	140	0.0280	....	....
	150	0.0830	150	0.0222	....	....
	160	0.0665	160	0.0176	0.0164	....
	170	0.0530	170	0.0140	....	....
	180	0.0415	180	0.0112	....	....
	190	0.0325	182	....	....	0.0123
	200	0.0255	190	0.0092	....	....
		0.0205	200	0.0076	0.0088	....
		0.0165	207	....	....	0.0071
			210	0.0064	....	....
			220	0.0055	....	....
Previous results by			240	....	0.0052	....
Boyer-Guillon, 1900, Melcher,			244	....	....	0.0046
1910, and Hall, Robb and			280	....	0.0036	....
Coleman, 1926, for "soluble			316	....	....	0.0031
anhydrite" agree fairly well			320	....	0.0026	....
with the above values for			360	....	0.0018	....
hemi-drate. Results by Hall,			400	....	0.0010	....
Robb and Coleman, 1926, for						
anhydrite do not agree with						
the above.						

Data for the solubilities in water at 20° of samples of gypsum burned for gradually increasing lengths of time at selected fixed temperatures, varying from 200° to 800°, are given by Budnikoff and Syrkin, 1922. Results are also given showing the rate of solution of two samples of gypsum burned respectively at 115° and 125°.

Data are given by Sworykin, 1927, for the rate of solution of natural calcium sulfate hemi-hydrate which has been previously heated to temperature varying from 100° to 1000°.

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID Results of Castagnou and Larcebau, 1951 at 10°

Wt. % H_2SO_4	Gms. CaSO_4 per 100 ml. sat. sol.	Wt. % H_2SO_4	Gms. CaSO_4 per 100 ml. sat. sol.
10	0.0125	60	0.202
20	0.049	80	0.337
40	0.071	100	3.530
			(4.800 at "room temp")

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID-Cont.

Results of Van Veldhulzen, 1929 at low acidities (25°):

Gm. mols. per liter		Gm. mole. per liter	
H ₂ SO ₄	CaSO ₄	H ₂ SO ₄	CaSO ₄
0.01	0.0308	0.05	0.0303
0.02	0.0305	0.06	0.0303
0.03	0.0303	0.07	0.0303
0.04	0.0301	0.08	0.0303

Results of Cameron and Breazeale, 1903 in more concentrated solutions: 30

Grams H ₂ SO ₄ per Liter of Solution	Results at 25°		Results in 35°	Results at 43°
	Gms. CaSO ₄ per Liter	Density Sat. Sol.	Gms. CaSO ₄ per Liter	Gms. CaSO ₄ per Liter
0.00	2.126	0.9991	...	2.145
0.48	2.128	1.0025	2.209	2.236
4.87	2.144	1.0026	2.451	2.456
8.11	2.203	1.0051	...	2.760
16.22	2.382	1.0098	...	3.116
48.67	2.727	1.0302	3.397	3.843
75.00	2.841	1.0435	...	4.146
97.35	2.779	1.0756	3.606	...
146.01	2.571	....	3.150	4.139
194.70	2.313	1.1134	...	3.551
243.35	1.901	1.1418	...	2.959
292.02	1.541	1.1681	...	2.481

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF ARSENIC ACID AT 25°
(Zieler, 1927)

The mixtures were shaken for 3 hours and the calcium in the saturated solutions precipitated as oxalate.

Gms. H ₃ AsO ₄ per 100 gms. aq. solvent	Gms. CaSO ₄ per 100 cc sat. sol.	Gms. H ₃ AsO ₄ per 100 gms. aq. solvent	Gms. CaSO ₄ per 100 cc sat. sol.
0.0 (= H ₂ O)	0.216	50.0	0.561
8.0	0.445	64.0	0.375
16.0	0.544	80.0	0.194
32.0	0.650		

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN CHROMIC ACID SOLUTIONS (Ryss, Zajarnij, and Zeljanskaja, 1941)

	Gms. per 100 gms. H ₂ O		Solid Phase	Gms. per 100 gms. H ₂ O		Solid Phase
	CrO ₃	CaSO ₄		CrO ₃	CaSO ₄	
30	Results at 25°			Results at 60° (Con.)		
	2.677	0.684	CaSO ₄ .2H ₂ O	49.10	3.74	CaSO ₄ .2H ₂ O
	6.76	1.14	"	50.19	3.63	"
	17.11	2.13	"	57.62	3.40	"
	26.48	2.332	"	72.07	2.85	"
	27.01	2.29	"	90.46	1.79	CaSO ₄
	27.21	2.332	"	139.2	0.842	"
	37.40	2.232	"	168.74	0.511	"
	41.90	2.204	"	176.2	0.503	" + CrO ₃
	79.82	1.445	"	176.2	0.502	" "
	95.20	1.260	"			
	116.3	1.106	"			
	131.1	0.826	"			
	166.0	.675	" + CrO ₃			
	169.6	.678	" "			
	Results at 60°			Results at 95°		
2.37	0.994	CaSO ₄ .2H ₂ O	1.493	1.021	CaSO ₄	
3.758	1.44	"	5.043	2.50	"	
8.982	2.35	"	10.55	3.75	"	
14.26	2.93	"	17.16	3.96	"	
15.45	3.16	"	25.47	3.95	"	
22.95	3.66	"	31.81	3.81	"	
24.61	3.70	"	83.20	2.32	"	
27.68	3.72	"	90.62	2.16	"	
31.43	3.77	"	98.45	1.94	"	
			107.20	1.80	"	
			144.1	1.233	"	
			200.3	0.517	" + CrO ₃	
			201.1	0.531	" "	
	Result at approximately 24° (20°-26°)					
			30.56	2.36	CaSO ₄ .2H ₂ O	

SOLUBILITY OF CALCIUM SULFATE IN HYDROCHLORIC ACID SOLUTIONS

Results of Banthisch, 1884 (See also Lunge, 1885) at 25° and 102°			Results of Van Veldhul- zen, 1929 (25°)		Results of Ryss and Nilus, 1955 at 25°		
Grams Acid per 100 cc. Solution	Grams CaSO ₄ per 100 cc. Sol.		Moles per liter sat. sol.		Gms. per 100 gms. sat. sol.		Solid Phase
	at 25°	at 102°	HCl	CaSO ₄	HCl	CaSO ₄	
0	0.208	0.160	0.01	0.0360	3.56	1.50	CaSO ₄ ·2H ₂ O
1	0.72	0.38	0.02	0.0407	6.48	1.80	"
2	1.02	2.38	0.03	0.0453	9.15	1.85	"
3	1.25	3.20	0.04	0.0494	12.08	1.73	"
4	1.42	3.64	0.05	0.0531	15.09	1.56	"
6	1.65	4.65	0.06	0.0565	18.33	1.27	"
8	1.74	..	0.07	0.0602	21.15	1.04	"
10	..	..	0.08	0.0634	24.26	0.88	"
12	..	..			26.73	0.75	"
					30.61	0.64	CaSO ₄

SOLUBILITY OF $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ IN SOLUTION OF $\text{HCl} + \text{CaCl}_2$ AT 20°
(Kuznetsov, 1946)

Solvent Wt. %		Gms. CaSO_4 per 1000 gms. Sat. Sol.	Solvent Wt. %		Gms. CaSO_4 per 100 gms. Sat. Sol.
HCl	CaCl_2		HCl	CaCl_2	
20.0	0.0	12.64	4.0	20.0	0.47
16.0	5.0	2.63	4.0	15.0	0.93
16.0	0.0	16.11	4.0	10.0	1.89
12.0	10.0	1.46	4.0	5.0	4.20
12.0	5.0	3.97	4.0	0.0	15.75
12.0	0.0	18.78	0.0	25.0	0.17
8.0	15.0	0.93	0.0	20.0	0.29
8.0	10.0	1.98	0.0	15.0	0.47
8.0	5.0	4.85	0.0	10.	0.69
8.0	0.0	19.80	0.0	5.0	0.99
			0.0	0.0	2.08

30

SOLUBILITY OF CALCIUM SULFATE IN PHOSPHORIC ACID SOLUTIONS

The data of D'Ans and Hofer, 1937 are higher than those of other investigators. Those of Sanfourche and Krapivine, 1933 are in fair agreement with the results of Taperova, 1940 and Taperova and Shulgina, 1955. For additional data see Taber, 1906.

(Taperova, 1940)

Gms. per 100 gms. Sat. Sol.			Gms. per 100 gms. Sat. Sol.		
P_2O_5	CaSO_4	Density	P_2O_5	CaSO_4	Density
Results at 25°					
Solid Phase CaSO_4			Solid Phase $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$		
0.0	0.27	1.006	36.80	0.80	...
8.24	.73	1.071	41.13	.57	1.377
21.05	.75	1.175	47.00	.32	1.445
24.82	.66	1.201	51.20	.20	1.519
31.33	.51	1.273	56.06	.09	1.520
35.04	.39	1.310	61.15	.08	1.633
42.40	.27	...			
44.77	.23	1.449			
46.57	.16	1.470			
48.80	.12	1.478			
55.56	.02	1.914			
63.51	Trace	...			
Solid Phase $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$					
0.0	0.20	1.007	25.39	0.61	1.220
4.70	.51	1.035	29.65	.56	1.273
4.77	.46	1.035	31.54	.53	1.292
8.24	.58	1.070	34.14	.49	1.314
10.07	.62	1.079	39.40	.39	1.385
19.99	.68	1.150	44.48	.32	1.444
18.37	.70	1.148	46.70	.29	1.490

(Cont.)

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN PHOSPHORIC ACID SOLUTIONS--Cont.

(Taperova, 1940)--Cont.

Gms. per 100 gms. Sat. Sol.		Density	Gms. per 100 gms. Sat. Sol.		Density		
P ₂ O ₅	CaSO ₄		P ₂ O ₅	CaSO ₄			
Results at 25°--Cont.							
Solid Phase CaSO ₄ ·2H ₂ O--Cont.							
18.80	0.70	1.164	47.60	0.28	1.500		
19.43	.58	1.171	51.22	.22	1.520		
25.09	.66	1.215	55.00	.17	1.530		

30

Results at 80°

Solid Phase CaSO ₄			Solid Phase CaSO ₄ ·2H ₂ O		
0.0	0.17	1.00	0.0	0.19	1.00
1.97	.44	1.004	1.00	.44	1.00
2.92	.51	1.009	1.97	.58	1.004
3.91	.58	1.024	2.15	.56	1.005
3.94	.58	1.029	2.92	.66	1.008
5.88	.68	1.088	3.91	.75	1.024
6.78	.88	1.050	4.98	.83	1.028
8.08	1.00	1.065	5.88	.88	1.038
16.00	1.09	1.127	6.78	.95	1.050
30.65	0.85	1.274	7.78	1.02	1.060
31.49	.92	1.283	8.11	1.17	1.065
32.24	.80	1.292	10.40	1.22	1.077
40.80	.51	1.395	12.53	1.34	1.090
41.30	.58	1.400	14.02	1.31	1.098
41.60	.54	1.404	18.18	1.40	1.140
54.70	.17	1.585	20.00	1.44	1.160
56.43	.10	1.615	20.50	1.41	1.160
61.63	Trace	1.693	22.60	1.41	1.180
Solid Phase CaSO ₄ · $\frac{1}{2}$ H ₂ O			25.00	1.28	1.210
24.80	1.615	1.200	25.20	1.40	1.210
28.50	1.52	1.239	30.34	1.31	1.260
29.00	1.53	1.250	30.48	1.35	1.260
31.48	1.42	1.269	34.46	1.26	1.320
33.86	1.29	1.299	35.50	1.26	1.320
38.30	1.06	1.360	35.50	1.28	1.320
40.01	0.90	1.365	40.01	1.11	1.380
40.00	.91	1.365	44.46	0.95	1.430
42.00	.85	1.399			

SOLUBILITY OF CALCIUM SULFATE IN PHOSPHORIC ACID SOLUTIONS--Cont.

Data of Taperova and Shulgina, 1945

		Solid Phase							
		CaSO ₄		CaSO ₄ ·2H ₂ O		CaSO ₄ ·2H ₂ O			
Gms. P ₂ O ₅	Gms. P ₂ O ₅	Gms. per	Gms. per	Gms. per	Gms. per	Gms. per	Gms. per	Gms. per	
per 100 gms.	per liter	100 gms.	liter	100 gms.	liter	100 gms.	liter	100 gms.	
Density	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	
Results at 40°									
1.2753	30	382.59	0.67	8.55	1.07	13.65	0.80	10.20	
1.3312	35	465.92	.55	7.33	0.85	11.32	.68	9.05	
1.3836	40	553.44	.36	4.98	.63	8.72	.53	7.33	
1.4424	45	649.08	.27	3.89	.47	6.78	.46	6.64	
1.5130	50	756.50	.18	2.73	.30	4.54	.39	5.90	
Results at 60°									
1.2342	25	308.55	0.85	8.16	1.44	17.67	1.05	12.94	
1.2841	30	382.23	.75	9.63	1.23	15.79	0.93	12.58	
1.3274	35	464.59	.62	8.24	1.02	13.54	.88	11.68	
1.3786	40	551.44	.48	6.62	0.79	10.89	.79	10.89	
1.4412	45	648.54	.32	4.62	.58	8.36	.69	9.94	
1.5007	48.5	727.83	..	..	.39	5.85	..	..
1.5104	50	755.20	.26	3.93	.35	5.29	.54	8.15	

SO

Results of Sanfourche and Krapivine, 1933

Gms. H ₃ PO ₄ per 100 cc of solvent	Gms. CaSO ₄ per 100 cc of sat. sol.	Solid Phase	Gms. H ₃ PO ₄ per 100 cc of solvent	Gms. CaSO ₄ per 100 cc of sat. sol.	Solid Phase
Results at 15°			Results at 70° (Con.)		
13.74	0.600	CaSO ₄ ·2H ₂ O	110.7	0.498	CaP + Ca ₂ ¹
27.65	0.756	"	138.0	0.231	" "
41.55	0.740	"			
55.3	0.598	"			Results at 80°
82.7	0.398	"			
110.7	0.308	"	13.74	1.124	CaSO ₄ ·2H ₂ O
138.0	0.357	"	27.65	1.598	"
			41.55	1.576	"
			55.3	1.454	"
			82.7	1.147	" + CaP + Ca ₂ ¹
			110.7	0.558	CaP + Ca ₂ ¹
			138.0	0.318	" + Ca
Results at 30°			Results at 90°		
13.74	0.800	CaSO ₄ ·2H ₂ O			
27.65	0.960	"			
41.55	0.895	"			
55.3	0.758	"			
82.7	0.518	"	13.74	1.234	CaSO ₄ ·2H ₂ O
110.7	0.392	"	27.65	1.655	"
138.0	0.112	CaP + Ca ₂ ¹	41.55	1.802	"
			55.3	1.749	Ca ₂ ¹
			82.7	1.165	" + CaP + CaSO ₄ ·2H ₂ O
			110.7	0.558	CaP + Ca ₂ ¹
			138.0	0.318	CaP + Ca
Results at 50°			Results at 100°		
13.74	0.932	CaSO ₄ ·2H ₂ O			
27.65	1.304	"			
41.55	1.219	"			
55.3	1.098	"			
82.7	0.825	"	41.55		
110.7	0.443	CaP + Ca ₂ ¹			Results at 105°
138.0	0.238	"	41.55		
Results at 70°			Results at 110°		
13.70	1.130	CaSO ₄ ·2H ₂ O			
27.65	1.484	"	82.7	1.345	CaP + Ca ₂ ¹ + Ca
41.55	1.462	"	110.7	0.479	CaP + Ca
55.3	1.299	"	130.8	0.126	CaP + Ca
82.7	1.002	"			

CaP = Ca(H₂PO₄)₂·H₂O, Ca₂¹ = CaSO₄·½H₂O, Ca = CaSO₄.

Ca CALCIUM

THE SOLUBILITY OF CALCIUM SULFATE IN PHOSPHORIC ACID SOLUTIONS--Cont.

Results of D'Ans and Hofer, 1937

Results at 25°			Results at 83°		
Gms. per 100 gms. H ₂ O		Solid Phase	Gms. per 100 gms. H ₂ O		Solid Phase
H ₃ PO ₄	CaSO ₄		H ₃ PO ₄	CaSO ₄	
0.0	0.25	CaSO ₄ ·2H ₂ O	0.0	(0.18)	CaSO ₄ ·H ₂ O
44.3	1.08	"	21.0	1.85	"
69.3	1.10	"	44.5	2.55	"
30 104.9	1.04	" + CaSO ₄	47.2	2.62	"
137.0	0.80	CaSO ₄ ·2H ₂ O	69.6	2.83	"
0.0	(0.55)	CaSO ₄ (anhydrite)	0.0	(0.12)	CaSO ₄
44.6	1.31	"	28.5	1.64	"
58.0	1.20	"	70.4	1.95	"
69.2	1.20	"	98.8	1.83	"
101.4	1.01	"	115.7	1.72	"
113.2	0.95	"	0.0	(0.28)	CaSO ₄ · $\frac{1}{2}$ H ₂ O
137.0	0.80	"	40.0	2.50	"
			68.6	2.54	"

SOLUBILITY OF CALCIUM SULFATE IN SOLUTIONS OF NITRIC, CHLORACETIC AND FORMIC ACIDS AT 25° (Banthisch, 1884; Lunge, 1885)

Gms. per 100 cc sol'n.		N HNO ₃ *	Gms. CaSO ₄ * per 100 cc Solution	Gms. Acid per 100 cc Solution	Gms. CaSO ₄ per 100 cc sat. sol.	
HNO ₃	CaSO ₄				in Chloracetic Acid	in Formic Acid
0	0.208	0	0.2169	0	0.208	0.208
1	0.56	0.01	.2630	4	0.22	0.24
2	0.82	0.05	.3042	10	0.25	...
3	1.02	0.10	.3869			
4	1.20					
6	1.48					
8	1.70					
10	1.84					
12	1.98					

*Results of Golovatyj, 1940.

THE SYSTEM CALCIUM SULFATE - CALCIUM HYDROXIDE - WATER AT 25° (Cameron and Seidell, 1906)

Gms. per Liter Sol.		Solid Phase	Gms. per Liter Sol.		Solid Phase
CaO	CaSO ₄		CaO	CaSO ₄	
0.0	2.126	CaSO ₄ ·2H ₂ O	0.939	1.634	CaSO ₄ ·2H ₂ O
0.062	2.030	"	1.222	1.588	" + Ca(OH) ₂
0.176	1.918	"	1.242	1.214	Ca(OH) ₂
0.349	1.853	"	1.150	0.666	"
0.61	1.722	"	1.166	0.00	"

SOLUBILITY OF CALCIUM SULFATE IN POTASSIUM HYDROXIDE SOLUTIONS AT 19°
(Golovatyj, 1940)

N	N _{KOH} :	0	0.01	0.05	0.10
Gms. CaSO ₄ /liter sat. sol.		2.169	2.169	2.428	1.474

THE SYSTEM CALCIUM SULFATE - CALCIUM CHLORIDE - WATER.

Results at 25°

(Cameron and Seidell, 1901) Grams per Liter Sol.		(Van Veldhulzen, 1929) Gm. mols. per liter		(Sveshnikova, 1949 d'Ans, 1933*) Gms. per 100 gms. sat. sol.		SO
CaCl ₂	CaSO ₄	CaCl ₂	CaSO ₄	CaCl ₂	CaSO ₄	
0.00	2.06	0.005	0.0137	0.16*	0.16	
7.49	1.24	0.010	0.0126	0.27*	0.14	
11.96	1.18	0.015	0.0118	0.44*	0.132	
25.77	1.10	0.020	0.0112	2.99	0.112	
32.05	1.08	0.025	0.0108	4.98*	0.103	
51.53	1.02	0.030	0.0104	9.24*	0.086	
97.02	0.84	0.040	0.0097	10.36*	0.091	
192.71	0.47	0.050	0.0093	20.30	0.031	
280.30	0.20			26.51	0.018	
367.85	0.03			27.53	0.021	
				33.87	0.011	
				38.91	0.008	

Results at 55°
(Sveshnikova, 1949)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CaCl ₂	CaSO ₄		CaCl ₂	CaSO ₄	
8.23	0.102	CaSO ₄ ·2H ₂ O	42.50	0.061	CaSO ₄ ·2H ₂ O
9.08	0.097	"	47.77	0.092	α-CaSO ₄ ·2H ₂ O
13.55	0.075	"	50.45	0.041	"
23.00	0.03	"	51.30	0.01	"
27.08	0.021	"	56.94	0.031	" + CaCl ₂ ·2H ₂ O
31.91	0.016	"			

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS
OF CALCIUM NITRATE AT 25°
(Seidell and Smith, 1904)

Gms. per Liter Sol.		Density	Gms. per Liter Sol.		Density
Ca(NO ₃) ₂	CaSO ₄		Ca(NO ₃) ₂	CaSO ₄	
0.0	2.08	0.998	300	0.76	1.204
25	1.24	1.014	400	0.57	1.265
50	1.20	1.032	500	0.40	1.328
100	1.13	1.067	544	0.35	1.352
200	0.93	1.137			

Ca CALCIUM

SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND SILVER SULFATE IN WATER (Euler, 1904)

t°		Per Liter of Solution Gms. Salt	Gms. Equiv. Salt	Total Salt per 100 Gms. Solution	Sp. Gr. of Solutions
17 ⁰	{ CaSO_4 Ag_2SO_4	2.31 7.235	{ 0.034 0.0464 }	0.9473	1.0083
25 ⁰	{ CaSO_4 Ag_2SO_4	2.61 8.11	{ 0.0383 0.0520 }	1.062	1.010

30 SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND CESIUM SULFATE IN WATER (D'Ans, 1908)

t°	Mols. $\text{Cs}_2\text{SO}_4 \cdot \text{CaSO}_4$ per 1000 Gms. Sat. Sol.	Gms. $\text{Cs}_2\text{SO}_4 \cdot \text{CaSO}_4$ per 1000 Gms. Sat. Sol.	Solid Phase
25	0.667	352	Dicalcium Sulfate + Gypsum
60	0.607	320	" "

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF COPPER SULFATE AT 25⁰ (Results of Bell and Taber, 1907)

Gms. per Liter Sat. Sol.		d_{25} Sat. Sol.	Gms. per Liter Sat. Sol.		d_{25} Sat. Sol.
CuSO_4	CaSO_4		CuSO_4	CaSO_4	
1.144	2.068	1.002	39.407	1.718	1.041
3.564	1.986	1.005	49.382	1.744	1.051
6.048	1.944	1.007	58.880	1.782	1.061
7.279	1.858	1.009	97.950	1.931	1.098
14.814	1.760	1.016	146.725	2.048	1.146
19.729	1.736	1.021	196.021	2.076	1.192
29.543	1.688	1.030	224.916	2.088	1.218

Results of Harkins and Paine, 1919

d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.	
	CuSO_4	CaSO_4
1.0010	0.1996	0.18435
1.0069	0.7922	0.1671
1.0149	1.5842	0.1661
1.0324	3.267	0.17468
1.1486	13.465	0.1944

THE SYSTEM CALCIUM SULFATE - POTASSIUM SULFATE - WATER
(Hill, 1934)

The mixtures used for the solubility determinations were made by careful weighing of the components, gypsum being used sometimes and dehydrated calcium sulfate at other times, and at still others syngenite or penta salt. The potassium sulfate was always brought into solution and the temperature adjusted before any calcium salt was added, to prevent the initiation of undesired phases by temporary conditions of wrong temperature or concentration.

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	SO
	K ₂ SO ₄	CaSO ₄		K ₂ SO ₄	CaSO ₄		
	Results at 40°			Results at 60° (Con.)			
0.9960	0.0	0.212	Ca ₂	3.599	0.169*	Ca ₂	
....	1.027	0.149	"	4.440	0.176*	" + CaK	
1.0108	2.066	0.147	"	5.178	0.134*	CaK	
1.0152	2.596	0.154	"	5.429	0.118*	"	
1.0187	2.917	0.155	" + Ca ₅ K	5.660	0.106	" + Ca ₅ K	
1.0192	3.123	0.159*	Ca ₂	6.172	0.099	CaK	
1.0210	3.526	0.163*	"	10.044	0.041	"	
....	3.710	0.165*	" + CaK	15.40	0.019	" + K ₂ SO ₄	
1.0252	3.956	0.143	Ca ₅ K + CaK	15.40	0.00	K ₂ SO ₄	
1.0258	4.061	0.134	CaK	0.0	0.160	Ca	
1.031	4.666	0.101	"	1.007	0.101	"	
1.032	4.797	0.094	"	2.013	0.107	"	
1.039	5.754	0.070	"	3.000	0.111	"	
1.056	7.763	0.040	"	3.562	0.114	"	
1.069	9.376	0.029	"	4.10	0.116	" + Ca ₅ K	
1.086	11.284	0.020	"	4.745	0.119*	Ca	
1.099	12.895	0.014	" + K ₂ SO ₄	5.32	0.121*	" + CaK	
1.099	12.897	0.010	K ₂ SO ₄	4.035	0.117	Ca ₅ K	
1.099	12.86	0.0	"	2.840	0.123*	"	
	Results at 55° (Sveshnikova, 1952)			Results at 100°			
....	0.0	0.183	Ca	0.0	0.167	Ca ₂	
....	1.30	.129	"	0.260	0.135	"	
....	9.83	.033	CaK	0.787	0.133	"	
....	5.02	.108	Ca ₅ K	1.090	0.136	" + Ca ₅ K	
....	15.09	.007	CaK + K ₂ SO ₄	1.521	0.140*	Ca ₂	
....	5.92	.095	CaK + Ca ₅ K	2.016	0.148*	"	
....	2.94	.125	Ca	2.962	0.162*	"	
....	4.20	.120	Ca + Ca ₅ K	4.522	0.184*	"	
	Results at 60°			5.312	0.198*	"	
....	0.0	0.2015*	Ca ₂	5.37	0.199	" + CaK	
....	0.318	0.155*	"	5.523	0.200*	Ca ₂	
....	1.239	0.148*	"	5.322	0.203*	CaK	
....	1.660	0.150*	" + Ca ₅ K	5.511	0.191*	"	
....	1.854	0.151*	Ca ₂	5.547	0.186*	"	
....	2.449	0.156*	"	5.719	0.177*	"	
				6.019	0.163*	"	
				(Cont.)			

* = metastable equilibrium; Ca₂ = Gypsum, CaSO₄·2H₂O; Ca = Anhydrite, CaSO₄; CaK = Syngenite, CaSO₄·K₂SO₄·H₂O; Ca₅K = Pentacalcium potassium sulfate, (CaSO₄)₅·K₂SO₄·H₂O.

Ca CALCIUM

THE SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS
OF POTASSIUM SULFATE AND VICE VERSA--Cont.

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	K ₂ SO ₄	CaSO ₄		K ₂ SO ₄	CaSO ₄	
	Results at 100°--Cont.					
	7.030	0.127*	CaK	1.932	0.051	Ca
	8.019	0.102*	"	2.953	0.055	"
	8.110	0.100*	"	4.500	0.060	"
	9.1	0.084*	" + Ca	5.46	0.067	" + Ca ₅ K
50	9.851	0.076*	CaK	6.52	0.071*	Ca
	10.62	0.066	" + Ca ₅ K	7.323	0.084*	"
	11.62	0.055	CaK	8.10	0.086*	"
	13.608	0.042	"	8.50	0.085*	"
	14.150	0.039	"	8.43	0.079*	"
	14.375	0.038	"	2.558	0.090*	Ca ₅ K
	16.221	0.033	"	4.021	0.082*	"
	19.317	0.026	" + K ₂ SO ₄	5.221	0.069*	"
	19.366	0.0	K ₂ SO ₄	6.817	0.064	"
	0.0	0.067	Ca	8.336	0.064	"
	0.448	0.051	"	9.958	0.063	"
	0.728	0.047	"			

Results at Other Temperatures

t°				t°			
25	3.067	0.148	Ca ₂ + CaK	35	0.04	0.230	Ca
31.8	3.363	0.155	"		0.08	0.218	"
83.	8.505	0.076	Ca ₅ K + CaK		0.12	0.207	"
				45	0.10	0.183	"
					0.50	0.192	"

* = metastable equilibrium; Ca₂ = Gypsum, CaSO₄·2H₂O; Ca = Anhydrite, CaSO₄; CaK = Syngenite, CaSO₄·K₂SO₄·H₂O; Ca₅K = Pentacalcium potassium sulfate, (CaSO₄)₅·K₂SO₄·H₂O.

OLDER DATA ON THE SYSTEM CaSO₄ + K₂SO₄ + H₂O

Data for the solubility of syngenite, K₂Ca(SO₄)₂·H₂O, and of potassium pentacalcium sulfate, K₂Ca₅(SO₄)₆·H₂O, in water at various temperatures, are given by D'Ans (1909). This author also gives results for the effect of the following salts upon the concentration of the boundary solution for gypsum-potassium syngenite at 25°: KCl, KBr, KI, KClO₃, KClO₄, KNO₃, CH₃COOK, KOH, K₄Fe(CN)₆, K₃Fe(CN)₆, NaCl, NaI, NaNO₃, CH₃COONa, HCl, HNO₃, H₃PO₄, CH₃COOH, H₂SO₄, Ag₂SO₄ and cane sugar.

Data for the solubility of mixtures of CaSO₄·K₂SO₄·H₂O + CaSO₄·2H₂O and CaSO₄·K₂SO₄·H₂O + K₂SO₄ in water at temperatures between 0° and 99°, are given by Barre (1909, 1911).

Results of Van Veldhulzen, 1929 at 25°:

moles K ₂ SO ₄ per liter	0.005	0.010	0.015	0.025
" CaSO ₄ " "	0.0139	0.0128	0.0122	0.0115

SOLUBILITY OF CALCIUM POTASSIUM DOUBLE SULFATES IN WATER AT 100°
(Anderson and Neatell, 1920)

The mixtures were constantly agitated at 100° for 7 to 23 days.

Gme. per 100 gms. H ₂ O		Mols. per 1000 mola. H ₂ O		Solid Phase
K ₂ SO ₄	CaSO ₄	K ₂ SO ₄	CaSO ₄	
1.02	0.180	1.04	0.24	5CaSO ₄ ·K ₂ SO ₄ ·H ₂ O + CaSO ₄ ·2H ₂ O
8.95	0.107	9.26	0.142	" + CaSO ₄ ·K ₂ SO ₄ ·H ₂ O (Syngenite)

30

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM SULFATE
ALONE AND CONTAINING HNO₃ OR KOH AT 19°
(Golovatyj, 1940)

The temperature varied from 18° to 20°. The solvents used were K₂SO₄ solutions, and solutions of K₂SO₄ + HNO₃ and K₂SO₄ + KOH as listed below. The solubility of Calcium Sulfate is given in terms of gms. CaSO₄ per liter of solvent.

Gm. Equiv. K ₂ SO ₄ per liter of Solvent	Gme. K ₂ SO ₄ per liter of Solvent	0.1 N HNO ₃	0.05 N HNO ₃	0.01 N HNO ₃	H ₂ O	0.01 N KOH	0.05 N KOH	0.1 N KOH
0.0	0.0	3.869	3.042	2.630	2.169	2.169	2.428	1.474
0.004	.349	3.800	2.973	2.537	1.992	2.358	2.352	1.488
.008	.697	3.790	2.676	2.448	1.815	2.398	2.305	1.542
.016	1.394	3.512	2.578	2.320	1.474	2.292	2.392	1.461
.032	2.788	3.386	2.428	2.238	1.315	2.265	2.235	1.680
.064	5.576	3.228	2.400	2.156	1.196	2.097	2.197	1.849
.128	11.153	3.102	2.285	2.156	1.393	2.163	2.155	1.883
.256	22.305	2.925	2.048	2.002	1.681	2.129	2.156	1.827

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF
MAGNESIUM SULFATE AT 25°
(Results of Cameron and Bell, 1906a)

Grams per Liter Solution		Sp. Gr. of Solutions at $\frac{25}{25}$	Grams per Liter Solution		Sp. Gr. of Solutions at $\frac{25}{25}$
MgSO ₄	CaSO ₄		MgSO ₄	CaSO ₄	
0	2.046	1.0032	149.67	1.597	1.1377
3.20	1.620	1.0055	165.7	1.549	1.1479
6.39	1.507	1.0090	171.2	1.474	1.1537
10.64	1.471	1.0118	198.9	1.422	1.1813
21.36	1.478	7.0226	232.1	1.254	1.2095
42.68	1.558	1.0419	265.6	1.070	1.2382
64.14	1.608	1.0626	298.0	0.860	1.2624
85.67	1.617	1.0833	330.6	0.647	1.2877
128.28	1.627	1.1190	355.0	0.501	1.3023

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF
MAGNESIUM SULFATE AT 25°--Cont.

(Results of Harkins and Paine, 1919)

SO	Solid Phase $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$			Solid Phase Selenite Plates		
	d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.	
		MgSO_4	CaSO_4		MgSO_4	CaSO_4
	0.99911	0.0	0.20854	0.99905	0.0	0.20658
	0.99960	0.060294	0.19565	1.0004	0.13413	0.17886
	1.0001	0.12167	0.1848	1.0018	0.33161	0.16469
	1.00067	0.18339	0.1777	1.0044	0.63148	0.15592
				1.0099	1.2385	0.15912

THE SYSTEM CALCIUM SULFATE - AMMONIUM SULFATE - WATER
(Hill and Yanick, 1935)

The previous results of D'Ans 1909 and of Barre, 1909, 1911, are incomplete or erroneous.

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
$(\text{NH}_4)_2\text{SO}_4$ CaSO_4				$(\text{NH}_4)_2\text{SO}_4$ CaSO_4				$(\text{NH}_4)_2\text{SO}_4$ CaSO_4			
Results at 25°				Results at 50°				Results at 50°--Cont.			
0.0	0.21	Ca_2	0.0	0.210	Ca_2	34.40	0.331	Ca_5N			
0.16	0.172	"	0.53	0.155	"	36.50	0.315	"			
1.12	0.146	"	1.15	0.154	"	38.54	0.298	"			
3.33	0.162	"	2.21	0.162	"	43.65	0.246	"			
5.51	0.183	"	6.43	0.210	"	45.61	0.222	" + Am			
11.09	0.242	"	8.32	0.233	"	36.54	0.485*	Ca_2N			
22.22	0.335	"	10.69	0.260	"	37.54	0.452	" + Ca_2			
28.66	0.373	"	16.57	0.321	"	39.54	0.399	"			
34.85	0.386	" + CaN	19.16	0.345	"	43.22	0.310	"			
36.12	0.386	" + Ca_5N	24.15	0.390	" + Ca_5N	45.51	0.244	" + Am			
43.29	0.378	" + Am	25.47	0.400	Ca_2	45.65	0.0	Am			
35.06	0.379	CaN	30.96	0.432	"	Results at 75°					
35.74	0.347	"	34.90	0.449	" + CaN						
36.67	0.310	"	45.39	0.468*	" + Am	0.0	0.191	Ca_2			
39.41	0.224	"	36.44	0.381	CaN	0.53	0.147	"			
40.70	0.200	"	38.55	0.313	"	2.12	0.162	"			
41.20	0.191	"	39.12	0.294	" + Ca_5N	5.29	0.208	"			
43.24	0.142	" + Am	40.22	0.267	CaN	7.16	0.235	"			
34.77	0.429	Ca_5N	42.91	0.201	"	11.33	0.294	" + Ca_5N			
38.52	0.337	"	43.88	0.180	"	18.93	0.391	"			
41.47	0.300	"	45.31	0.157	" + Am	26.26	0.486	"			
43.24	0.259	" + Am	23.14	0.394"	Ca_5N	32.22	0.539	" + Ca_2N			
43.46	0.0	Am	29.80	0.361	"	33.58	0.545	"			

* = metastable equilibrium; $\text{Ca}_2 = \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$; $\text{CaN} = \text{Synigenite } \text{CaSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{O}$; $\text{Ca}_5\text{N} = \text{Penta calcium salt, } 5\text{CaSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{O}$; $\text{Ca}_2\text{N} = \text{Dicalcium salt, } 2\text{CaSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{O}$; Ca = Anhydrite, CaSO_4 . Am = $(\text{NH}_4)_2\text{SO}_4$.

THE SYSTEM CALCIUM SULFATE - AMMONIUM SULFATE - WATER--Cont.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid
(NH ₄) ₂ SO ₄ CaSO ₄			(NH ₄) ₂ SO ₄ CaSO ₄			(NH ₄) ₂ SO ₄ CaSO ₄		
Results at 75°--Cont.			Results at 75°--Cont.			Results at 100°--Cont.		
32.28	0.568	Ca ₂ + CaN	30.86	0.212	Ca	39.36	0.300	Ca ₂ N
35.72	0.522	CaN	42.20	0.221	"	45.68	0.229	"
37.90	0.438	"	47.95	0.180	" + Am	48.44	0.212	"
39.88	0.371	" + Ca ₂ N	48.00	0.0	Am	50.40	0.204	" + Am
42.01	0.308	"				9.76	0.214	Ca ₂ N
42.82	0.289	"	Results at 100°			18.53	0.236	"
45.94	0.224	"	0.0	0.167	Ca ₂	24.68	0.254	"
48.00	0.185	" + Am	0.56	0.152	"	28.55	0.252	"
11.94	0.295	Ca ₂ N	1.63	0.152	"	32.15	0.248	"
17.04	0.303	"	9.24	0.200	" + Ca ₂ N	37.48	0.244	"
27.24	0.300	"	5.69	0.226	"	41.03	0.237	"
34.38	0.276	"	11.40	0.327	"	44.64	0.223	"
37.21	0.267	"	16.07	0.404	"	47.74	0.212	"
43.55	0.229	"	21.81	0.518	"	50.37	0.201	" + Am
47.96	0.181	" + Am	24.21	0.555	"	0.0	0.066	Ca
32.71	0.530	Ca ₂ N	28.79	0.630	"	0.53	0.042	"
34.62	0.482	"	35.77	0.715	" + CaN	1.09	0.047	"
35.91	0.442	"	36.46	0.657	CaN	3.61	0.058	"
39.17	0.380	"	39.12	0.532	"	8.52	0.085	"
45.35	0.279	"	41.09	0.461	"	15.61	0.125	"
47.93	0.243	" + Am	43.26	0.392	"	22.02	0.145	"
0.0	0.114	Ca	48.51	0.280	"	26.56	0.155	"
0.52	0.074	"	50.41	0.245	" + Am	36.52	0.177	"
2.07	0.082	"	22.98	0.505	Ca ₂ N	46.59	0.193	"
10.35	0.133	"	27.90	0.441	"	50.41	0.198	" + Am
23.62	0.212	"	33.37	0.372	"	50.45	0.0	Am

S0

* = metastable equilibrium; Ca₂ = CaSO₄·2H₂O; CaN = Synygenite CaSO₄.
 (NH₄)₂SO₄·H₂O; Ca₂N = Penta calcium salt, 5CaSO₄·(NH₄)₂SO₄·H₂O;
 Ca₂N = Dicalcium salt, 2CaSO₄·(NH₄)₂SO₄·H₂O; Ca = Anhydrite, CaSO₄.
 Am = (NH₄)₂SO₄.

SOLUBILITY OF CaSO₄ IN (NH₄)₂SO₄ SOLUTIONS

Results at 25° (Sullivan, 1905)			Results at 50° (Bell and Tabor, 1906)		
Grams per Liter Sol.		Density	Grams per Liter Sol.		Sp. Gr. of Solutions
(NH ₄) ₂ SO ₄	CaSO ₄		(NH ₄) ₂ SO ₄	CaSO ₄	
0	2.08	0.9991	0	2.168	....
0.129	2.04	0.9991	15.65	1.609	1.0026
0.258	1.99	0.9992	30.67	1.750	1.0113
0.821	1.81	0.9995	91.6	2.542	1.0440
1.643	1.66	0.9999	160.4	3.402	1.0819
3.287	1.54	1.0010	221.6	4.068	1.1108
6.575	1.44	1.0034	340.6	5.084	1.1653
13.15	1.46	1.0082	416.5	5.354	1.1964
26.30	1.62	1.0176	428.4	4.632	1.2043
84.9	2.33	1.0534	530.8	2.152	1.2437
160.8	3.33	1.1032	566.0	1.08	1.2508
339.6	4.50	1.1915	566.7	0	1.2510

Ca CALCIUM

THE SYSTEM CALCIUM SULFATE - SODIUM SULFATE - WATER
(Hill and Wills, 1938)

For other (older) data see D'Ans (1909); Barre (1911); Seidell, Smith, Cameron and Breazeale.

Accurately weighed mixtures of the constituents were rotated in stoppered bottles for appropriate periods and the saturated solutions analyzed by evaporating a part to constant weight at 100° and then at 200° and precipitating the calcium in another part as oxalate and weighing as oxide.

30 Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Na ₂ SO ₄	CaSO ₄	Solid Phase	Na ₂ SO ₄	CaSO ₄	Solid Phase	Na ₂ SO ₄	CaSO ₄	Solid Phase
<u>Results at 25°</u>			<u>Results at 25° (Con.)</u>			<u>Results at 35° (Con.)</u>		
0.0	0.209	Ca ₂	34.13	0.055	CaNa + Na	32.85	0.178	Ca ₂ + Na
0.595	0.148	"	32.72	0.070	"	32.90	0.0	Na
1.601	0.139	"	32.49	0.070	"	32.89	0.046	" + CaNa
3.200	0.144	"	31.41	0.094	"	29.31	0.084	CaNa
6.251	0.161	"	31.05	0.123	"	28.34	0.099	"
10.93	0.181	"	30.47	0.115	"	25.17	0.146	"
15.23	0.194	"	30.34	0.141	"	23.06	0.199	"
18.09	0.197	"	34.00	0.0	Na	22.65	0.206	" + Ca ₂
20.15	0.198	"				32.85	0.065	Ca ₂ Na + Na
21.75	0.197	" + Na ₁₀	<u>Results at 35°</u>			31.66	0.078	"
25.87	0.188*	" + CaNa				31.18	0.088	"
27.98	0.180*	"	0.0	0.214	Ca ₂	30.48	0.102	"
29.78	0.174*	" + Ca ₂ Na	0.503	0.150	"	27.25	0.176	"
33.85	0.155*	" + Na	0.988	0.142	"	26.70	0.200	" + Ca ₂
21.70	0.0	Na ₁₀	1.896	0.142	"	27.93	0.217	Ca ₂ Na
21.72	0.120	"	5.968	0.164	"	30.06	0.189	" + Ca ₂
33.91	0.049	CaNa + Na	13.97	0.198	"	31.01	0.179	"
32.61	0.065	"	25.16	0.204	"	31.4	0.166	"
29.31	0.113	"	27.93	0.199	"	32.5	0.144	"
26.60	0.175	"	29.89	0.190	"	32.88	0.135	" + Na
<u>Results at 50°</u>			<u>Results at 50°</u>			<u>Results at 50°</u>		
0.0	0.210	Ca ₂	1.236	0.135	Ca	31.67	0.060	Ca ₂ Na + Na
0.521	0.154	"	1.529	0.135	"	26.61	0.124	"
0.989	0.149	"	1.942	0.138	"	25.51	0.163	"
1.521	0.148	"	9.923	0.162	"	24.8	0.230	" + Ca ₂
1.981	0.149	"	31.70	0.040	CaNa + Na	24.51	0.277	"
3.908	0.164	"	29.08	0.058	"	31.7	0.147	Ca ₂ Na + Na
7.496	0.185	"	25.49	0.102	"	31.3	0.153	Ca ₂ Na
14.05	0.214	"	23.93	0.115	"	29.4	0.165	"
18.28	0.224	22	22.53	0.136	"	27.0	0.182	"
20.07	0.228	"	20.24	0.182	"	25.2	0.202	" + Ca ₂ Na
24.40	0.230	"	19.68	0.197	"	23.6	0.213	"
26.93	0.230	"	19.66	0.203	" + Ca	22.8	0.217	"
29.75	0.224	"	18.71	0.227	" + Ca ₂	21.6	0.226	"
31.77	0.216	" + Na	18.44	0.233	"	21.4	0.229	" + Ca ₂
31.73	0.0	Na	17.88	0.252	"			

(Cont.)

Ca₂ = Gypsum, CaSO₄·2H₂O; CaNa = Glauberite, CaSO₄·Na₂SO₄; Ca₂Na = Labile Salt, CaSO₄·2Na₂SO₄·2H₂O; Ca₂Na = Penta salt, 5CaSO₄·Na₂SO₄·3H₂O; Ca = Anhydrite CaSO₄; Na = Thenardite, Na₂SO₄; Na₁₀ = Mirobilite Na₂SO₄·10H₂O.

THE SYSTEM CALCIUM SULFATE - SODIUM SULFATE - WATER--Cont.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Na ₂ SO ₄	CaSO ₄	Solid Phase	Na ₂ SO ₄	CaSO ₄	Solid Phase	Na ₂ SO ₄	CaSO ₄	Solid Phase
Results at 75°								
0.0	0.192	Ca ₂	9.95	0.113	Ca	28.46	0.110	Ca ₂ Na
0.506	0.142	"	14.47	0.117	"	26.17	0.154	"
1.009	0.143	"	18.92	0.128	" + CaNa	25.94	0.169	"
1.505	0.145	"	19.95	0.129	"	25.20	0.210	"
1.996	0.148	"	30.32	0.042	CaNa + Na	24.20	0.292	"
4.036	0.168	"	27.14	0.052	"	24.0	0.302	" + Ca ₂
8.046	0.199	"	26.76	0.054	"	10.2	0.221	Ca ₂ Na + Ca ₂ SO ₄
10.38	0.224	"	26.35	0.056	"	10.81	0.217	"
12.06	0.238	"	25.78	0.060	"	11.05	0.201	"
17.20	0.270	"	22.45	0.086	"	12.10	0.208	"
23.15	0.300	"	19.20	0.123	"	13.06	0.207	"
29.62	0.308	"	18.16	0.139	"	13.60	0.200	"
30.32	0.308	" + Na	16.30	0.175	"	14.25	0.197	"
30.38	0.0	Na	15.12	0.198	"	15.07	0.201	"
1.002	0.070	Ca	14.16	0.225	"	15.10	0.198	" + CaNa
5.017	0.086	"	13.85	0.247	" + Ca ₂	17.03	0.189	"
8.93	0.113	"	30.38	0.081	Ca ₂ Na + Na	19.08	0.185	"
9.205	0.103	"	29.06	0.103	"	26.2	0.160	" + Ca ₂ Na
						30.28	0.146	" + Na

Ca₂ = Gypsum, CaSO₄.2H₂O; CaNa = Glauberite, CaSO₄.Na₂SO₄; Ca₂Na = Labile Salt, CaSO₄.2Na₂SO₄.2H₂O; Ca₂Na = Penta salt, 5CaSO₄.Na₂SO₄.3H₂O; Ca = Anhydrite CaSO₄; Na = Thenardite, Na₂SO₄; Na₁₀ = Mirobilite Na₂SO₄.10H₂O.

Data for the solubility of CaSO₄ in Na₂SO₄ solutions at 182°, 207°, 244° and 316° are given by Straub, 1932. (Solubility decreases with increasing concentration of Na₂SO₄.)

SOLUBILITY OF CaSO₄ IN Na₂SO₄ SOLUTIONS CONTAINING H₂SO₄
(Kleinert and Wurm, 1952)

Results at 45°				Results at 60°				Results at 80°			
Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
H ₂ SO ₄	Na ₂ SO ₄	CaSO ₄	Solid	H ₂ SO ₄	Na ₂ SO ₄	CaSO ₄	Solid	H ₂ SO ₄	Na ₂ SO ₄	CaSO ₄	Solid
9.32	0.0	0.365	2	9.34	0.0	0.525	2	9.25	0.0	0.767	Ca
9.33	2.04	.344	2	9.44	0.68	.493	2	9.35	1.02	.709	Ca
9.21	2.82	.318	2	9.15	3.32	.415	2	9.23	2.80	.600	Ca
9.09	4.70	.279	2	9.12	4.87	.359	2	9.07	4.42	.506	Ca
8.89	7.07	.236	2	8.96	6.80	.315	2	8.93	7.11	.387	Ca
8.88	7.79	.222	2	8.92	7.93	.287	2	9.32	9.42	.292	Ca
8.46	14.15	.167	2	8.72	9.77	.248	2	8.69	11.12	.259	Ca
8.14	19.68	.150	2	8.61	11.44	.226	2	8.54	12.43	.240	Ca
7.85	22.63	.147	2	8.55	12.46	.205	2	8.39	14.71	.188	Ca
7.85	23.36	.145	2	8.27	16.56	.186	2	8.24	16.27	.171	Ca
7.67	25.21	.143	2 + D	8.16	19.56	.161	2	8.15	19.16	.137	Ca
7.63	25.26	.135	D	8.06	21.76	.161	2	8.04	21.61	.125	Ca + D
7.55	25.78	.112	D	7.72	23.11	.154	2	7.75	22.94	.070	D
7.29	27.84	.071	D	7.72	24.25	.151	2 + D	7.52	23.78	.066	D
7.01	31.13	.046	D	7.68	28.49	.052	D	7.76	25.07	.040	D
7.01	31.27	.044	D + Na	7.43	27.60	.061	D	7.67	26.27	.040	D
7.01	31.52	.018	Na	7.09	30.92	.035	D + Na	7.24	30.27	.019	D + Na
7.08	31.70	0.0	Na	7.11	31.23	0.0	Na	7.31	30.39	0.0	Na

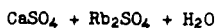
2 = CaSO₄.2H₂OD = Na₂SO₄.CaSO₄Na = Na₂SO₄Ca = CaSO₄

Ca CALCIUM

THE SYSTEM CALCIUM SULFATE - NICKEL SULFATE - WATER (Campbell and Yanick, 1932)

The solid phase was $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ in all cases except at the tr. pts. marked * when both $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ and $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ were present and for solutions saturated only with $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$.

	t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.	
		NiSO_4	CaSO_4		NiSO_4	CaSO_4		NiSO_4	CaSO_4
30	45	0.0	0.211	75	24.36	0.287	90	29.72	0.359
	"	6.23	0.220	"	33.32	0.294	"	31.09	0.350
	"	10.61	0.223	"	40.16	0.321	"	31.36	0.345
	"	20.42	0.243	"	40.88	0.315	"	34.16	0.340
	"	23.5	0.236	"	44.59	0.302	"	37.24	0.337
	"	25.45	0.246	"	49.70	0.276	"	40.06	0.335
	"	26.62	0.246	"	58.81	0.240	"	43.12	0.327
	"	29.43	0.255	"	51.25	0.220*	"	44.58	0.330
	"	35.03	0.252	"	60.30	0.0	"	46.61	0.326
	"	37.99	0.257	90	0.0	0.177	"	48.95	0.291
75	"	43.54	0.242	"	7.38	0.222	"	49.56	0.299
	"	49.31	0.200*	"	11.15	0.268	"	53.91	0.280
	"	48.36	0.0	"	16.23	0.309	"	57.88	0.265
	"	0.0	0.199	"	21.63	0.332	"	61.34	0.246
	"	7.69	0.226	"	23.76	0.348	"	72.40	0.186
	"	19.60	0.273	"	24.93	0.351	"	72.54	0.183
							"	68.70	0.0



Data for mixtures of gypsum-rubidium syngenite and of dicalcium salt-syngenite, at temperatures between 0° and 40° , are given by D'Ans (1909).

SOLUBILITY OF CALCIUM SULFATE IN POTASSIUM CHLORIDE SOLUTIONS

Results of Ditte (1898) at 21°
Gms. per liter

KCl	CaSO_4
0	2.05
10	3.6
20	4.5
40	5.8
60	6.6
80	7.2
100	7.5

Results of Van Veldhulzen (1929)
at 25°

Gm. mols. per liter

KCl	CaSO_4
0.01	0.0330
0.02	0.0350
0.03	0.0370
0.04	0.0393
0.06	0.0431
0.07	0.0451
0.08	0.0469
0.12	0.0551

THE SYSTEM $\text{CaSO}_4 + 2\text{KCl} \rightleftharpoons \text{CaCl}_2 + \text{K}_2\text{SO}_4$ aq.
(Svechnikova, 1949, 1951, 1952)

Results at 25°					Results at 55°				
Gms. per 100 gms. H ₂ O				Solid Phase	Gms. per 100 gms. sat. sol.				Solid Phase
K ₂ Cl ₂	K ₂ SO ₄	CaCl ₂	CaSO ₄		K ₂	Ca	Cl ₂	SO ₄	
0.209*	2.95	...	0.175	G + S	2.34	20.37	37.90	...	G + K
2.487*	1.54	...	.247	G + S	6.76	0.005	...	8.32	S + O
9.38*	...	0.404	.533	G + S	2.69	.03	...	3.25	S + S
30.26*	...	5.705	.174	G + S + K	1.93	.03	...	2.37	A + S
8.64	5.47	...	.020	S + O	16.40	...	14.36	0.71	K + O
18.30	2.68	...	.025	S + O	15.71	.007	14.04	0.71	S + K + O
28.99	...	4.21	.13	S + K	8.81	.04	5.48	3.52	S + O
35.60	1.02	...	.04	S + K + O	11.69	.02	10.09	0.27	S + K
33.88	...	0.83	.17	S + K	...	.01	8.35	2.84	S + O
19.46	...	12.31	.05	G + K	5.44	.06	4.55	0.81	S + S
17.20	...	14.29	.04	G + K	3.21	.03	1.16	2.37	S
0.075	...	...	.226	G	2.65	.04	1.18	1.77	A + S
0.150	...	...	.240	G	8.25	.06	5.38	2.94	S
0.452	...	...	.310	G	2.50	.04	0.79	2.10	S
0.604	...	...	.323	G	16.08	.45	15.81	0.11	A + K
0.907	...	...	.380	G	3.19	.05	1.93	1.42	A + S
					5.65	.09	4.82	.065	A + S
					9.05	4.60	16.00	0.09	A + K
					1.98	19.98	37.15	0.005	A + D + G
					4.24	18.09	36.21	0.005	K + D + A

*D'Ana, 1933. G - $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ K - KCl A - CaSO_4
 S - $\text{CaSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ O - K_2SO_4 5 - $5\text{CaSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
 D - $\text{CaSO}_4 \cdot \text{K}_2\text{SO}_4$

SOLUBILITY OF CALCIUM SULFATE IN SOLUTIONS OF POTASSIUM SALTS

Results at 21°
(Ditte, 1898)

Grams of the Potassium Salt per Liter	In KBr Solutions	In KI Solutions
	Gms. CaSO ₄ per Liter	Gms. CaSO ₄ per Liter
0	2.05	2.05
10	3.1	2.8
20	3.6	3.2
40	4.5	3.9
60	5.2	4.5
80	5.9	4.85
100	6.3	5.1
125	6.7	5.45
150	7.0	5.8
200	7.3	5.95
250	double salt	6.00
300	...	double salt

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN SOLUTIONS OF POTASSIUM SALTS--Cont.

Results at 25°

(Seidell and Smith, 1904; Cameron and Breazeale, 1904)

	In Potassium Nitrate			In Potassium Sulphate		
	Gms. per Liter Solution		Wt. of 1 cc. Solution	Gms. per Liter Solution		Wt. of 1 cc. Solution
	KNO ₃	CaSO ₄		K ₂ SO ₄	CaSO ₄	
	0.0	2.08	0.9981	0.0	2.08	0.9981
	12.5	3.28	1.0081	4.88	1.60	1.0036
	25.0	4.08	1.0154	5.09	1.56	1.0038
	50.0	5.26	1.0321	9.85	1.45	1.0075
	100.0	6.86	1.0625	19.57	1.49	1.0151
	150	7.91	1.0924	28.35	1.55	1.0229
	200	8.69	1.1224	30.66	1.57	1.0236
	260	syngenite	1.1539	32.47	1.58*	....

Data of Harkins and Paine (1919)

Gms. per 100
gms. sat. sol.

*Solid phase syngenite. Results for the solubility of syngenite in solutions of potassium sulphate are also given in the original paper.

	KNO ₃	CaSO ₄	d ₂₅ of sat. sol.
0.0		0.20854	0.99911
0.27824		0.2454	1.0013
0.53106		0.27268	1.0029
1.0330		0.2862	1.0088

Results of Van Veldhulzen (1929) at 25°

Potassium Ferricyanide		Potassium Ferrocyanide		Luteo Cobaltic Chloride	
Gm. mols. per liter		Gm. mols. per liter		Gm. mols. per liter	
K ₃ Fe(CN) ₆	CaSO ₄	K ₃ Fe(CN) ₆	CaSO ₄	Co(NH ₃) ₆ Cl ₃	CaSO ₄
0.00167	0.0163	0.001269	0.0167	0.00333	0.0175
0.00333	0.0172	0.002538	0.0176	0.00667	0.0201
0.00667	0.0188	0.005075	0.0197	0.01000	0.0222

SOLUBILITY OF CALCIUM SULFATE IN SODIUM CHLORIDE SOLUTIONS

The various data are in good agreement.

Result at 26° (Cameron, 1901; also Orloff, 1902; Cloeze, 1903; d'Anselme, 1903)			Results at 25° (Shternina, 1948, 1949) The presence of up to 1 atm. of CO ₂ did not affect the solubility. Results for very dilute NaCl solutions are given by Shternina and Frolova, 1952.				
Grams per 100 cc. Solution		Density Sat. Solution	Gms. per 100 cc Solution		Gms. per 100 cc. Solution		50
NaCl	CaSO ₄		NaCl	CaSO ₄	NaCl	CaSO ₄	
0	0.2121	0.9998	1.981	0.431	16.816	0.716	
9.115	0.666	1.0644	5.003	.600	18.073	.706	
14.399	0.718	1.0981	8.610	.687	23.152	.665	
14.834	0.716	1.1012	11.988	.722	28.348	.610	
17.650	0.712	1.1196	13.876	.724	31.721	.582	
22.876	0.679	1.1488	15.215	.723			
26.417	0.650	1.1707					
32.049	0.572	1.2034					

Results for the solubility of CaSO₄ in NaCl solutions from 100-230° in graph form are given by Zdanovskii (1949).

Data for the solubility of mixtures of calcium sulfate and sodium chloride at 0°-99° are given by Arth and Cretien (1906).

SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND CALCIUM CARBONATE IN
AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 23°
(Cameron and Seidell, 1901a)

Grams per Liter Solution			Grams per Liter Solution		
NaCl	Ca(HCO ₃) ₂	CaSO ₄	NaCl	Ca(HCO ₃) ₂	CaSO ₄
0	0.060	1.930	79.52	0.060	6.424
3.63	0.072	2.720	121.90	0.056	5.272
11.49	0.089	3.446	193.80	0.048	4.786
39.62	0.101	5.156	267.60	0.040	4.462

SOLUBILITY OF CALCIUM SULFATE IN SEA WATER AT 30°
(Posujak, 1940)

The author determined the solubility of CaSO₄·2H₂O and CaSO₄ in "Normal" Sea Water which was prepared in the laboratory and was the average composition of Sea Water throughout the world, as found by Dittmar (1884). The composition of "Normal" Sea Water in grams per 1000 gms. H₂O is:

NaCl	27.21	K ₂ SO ₄	0.863
MgCl ₂	3.81	CaCO ₃	.123
MgSO ₄	1.66	MgBr ₂	.076
CaSO ₄	1.260	+ Minor amounts of other salts.	

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN SEA WATER AT 30°—Cont.

The author's solvent contained NaCl, MgCl₂, MgSO₄ and K₂SO₄. Data are given in terms of gms. CaSO₄ per 100 gms. H₂O.

Concentration* of Sea Salts	Solid Phase		Concentration of Sea Salts	Solid Phase	
	CaSO ₄ ·2H ₂ O	CaSO ₄		CaSO ₄ ·2H ₂ O	CaSO ₄
0.0	0.209	0.250	3.0	0.432	0.470
0.5	.366	.414	3.6	.412	.436
1.0	.418	.468	5.0	.339	.336
2.0	.449	.488	5.5	.308	.288

80

*Equals the number of times the "Normal" salt concentration present. E.G. 1.0 = "Normal" Sea Water, 3.0 = Salt concentrations 3 times that in "Normal" Sea Water.

The precipitation of CaSO₄·2H₂O and CaSO₄ during Sea Water evaporation is discussed. Other data for the solubility in sea water are given by Manvelli, 1916.

Gilliert and Gilpin (1946) determined the solubility of Calcium Sulfate in Sea Water after the Magnesium Salts had been partially precipitated as Mg(OH)₂ by the addition of Lime.

Data for the equilibrium $\text{CaSO}_4 + \text{Na}_2\text{CO}_3 \rightleftharpoons \text{CaCO}_3 + \text{Na}_2\text{SO}_4$ (aq.) at 25° are given by Herz (1911a).

SOLUBILITY OF CaSO₄ IN Na₂S₂O₃ AND NaNO₃ SOLUTIONS AT 25°

Data of Van Veldhulzen,
1929

Data of Seidell, Smith, Cameron
and Breazeale

Gms. per Liter
Solution

Gm. mols. per liter				Density
Na ₂ S ₂ O ₃	CaSO ₄	NaNO ₃	CaSO ₄	
0.005	0.0170	0	2.08	0.9981
0.010	0.0185	25	4.25	1.0163
0.015	0.0198	50	5.50	1.0340
0.0200	0.0210	100	7.10	1.0684
		200	8.79	1.1336
		300	9.28	1.1916
		600	7.89	1.3639
		655	7.24	1.3904

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF MAGNESIUM CHLORIDE AND OF MAGNESIUM NITRATE AT 25° (Cameron, Seidell, and Smith)

In Magnesium Chloride
Grams per Liter
of Sat. Solution

In Magnesium Nitrate
Grams per Liter
Solution

Wt. of 1 cc.
Solution

MgCl ₂	CaSO ₄	H ₂ O	Mg(NO ₃) ₂	CaSO ₄	
0	2.08	997.9	0	2.08	0.9981
8.50	4.26	996.5	25	5.77	1.0205
19.18	5.69	994.5	50	7.88	1.0398
	(Cont.)		682	(Cont.)	

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF MAGNESIUM CHLORIDE AND OF MAGNESIUM NITRATE AT 25°--Cont.

In Magnesium Chloride (Cont.) Grams per Liter to Sat. Solution			In Magnesium Nitrate (Cont.) Grams per Liter Solution		Wt. of 1 cc. Solution
MgCl ₂	CaSO ₄	H ₂ O	Mg(NO ₃) ₂	CaSO ₄	
46.64	7.59	989.1	100	9.92	1.0786
121.38	8.62	972.2	200	13.34	1.1498
206.98	6.57	949.9	300	14.00	1.2190
337.0	2.77	908.7	400	14.68	1.2821
441.1	1.39	878.6	514	15.04	1.3553

50

Data of Van Veldhulzen, 1929

Gm. mols. per liter

MgCl ₂	CaSO ₄	MgCl ₂	CaSO ₄
0.00498	0.0170	0.01494	0.0197
0.00996	0.0184	0.01992	0.0208

THE SYSTEM $\text{CaSO}_4 + \text{MgCO}_3 \rightleftharpoons \text{CaCO}_3 + \text{MgSO}_4$ IN WATER AT 25°
(O. K. Yanat'eva, 1949)

Results in water Millimoles per 1000 gms. solution				Results in 2.0% NaCl aq. Millimoles per 1000 gms. solution				Solid Phase
Ca	Mg	(HCO ₃) ₂	SO ₄	Ca	Mg	(HCO ₃) ₂	SO ₄	
3.21	3.23	6.49	....	6.40	6.54	12.94	...	D
2.50	11.26	13.76	....	7.76	30.55	38.31	...	D + M
8.10	1.18	9.28	....	14.52	0.74	15.26	...	D + C
21.10	1.07	9.03	13.14	38.68	1.12	11.80	28.00	D + C + G
21.58	7.54	12.10	17.02	...	...	...	...	D + G
21.08	17.31	15.95	22.44	33.24	14.72	14.47	33.49	D + M + G
6.01	153.04	11.15	147.90	18.18	91.24	17.36	92.06	M + G

D = Dolomite $\text{CaCO}_3 \cdot \text{MgCO}_3$
C = Calcite CaCO_3

M = Magnesite MgCO_3
G = Gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

SOLUBILITY OF CALCIUM SULFATE IN SOLUTIONS OF AMMONIUM SALTS AT 25°
(Data of Cameron and Brown, 1905)

Gms. Ammonium Salt per Liter	In NH ₄ Cl G. CaSO ₄ Dissolved per Liter	In NH ₄ NO ₃ G. CaSO ₄ Dissolved per Liter	Gms. Ammonium Salt per Liter	In NH ₄ Cl G. CaSO ₄ Dissolved per Liter	In NH ₄ NO ₃ G. CaSO ₄ Dissolved per Liter
0	2.08	2.08	100	9.10	7.65
20	5.00	3.70	150	10.30	8.88
40	7.00	5.10	200	10.85	9.85
60	8.00	6.05	300	10.10	10.80
80	8.50	7.00	375	7.40	...

(Cont.)

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN SOLUTIONS OF AMMONIUM SALTS AT 25°-Cont.

Gms. Ammonium Salt per Liter	In NH_4Cl G. CaSO_4 Dissolved per Liter	In NH_4NO_3 G. CaSO_4 Dissolved per Liter	Gms. Ammonium Salt per Liter	In NH_4Cl G. CaSO_4 Dissolved per Liter	In NH_4NO_3 G. CaSO_4 Dissolved per Liter
400	...	11.40	1000	...	11.81
600	...	12.15	1400	...	10.02
800	...	12.10	sat.	...	7.55

In $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$
(Marden, 1916)

Gms. CH COONH per 100 Gms. Solution	d_{25}	Gms. CaSO per 100 Gms. Sat. Solution
0	1.000	0.2085
2.13	1.005	0.454
5.34	1.012	0.752
10.68	1.024	1.146
21.37	1.045	1.755

THE SYSTEM CALCIUM SULFATE - UREA - WATER
(Data of Uno, 1940)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CO(NH ₂) ₂	CaSO ₄	Solid Phase	CO(NH ₂) ₂	CaSO ₄	Solid Phase
Results at 0°			Results at 30° (Con.)		
40.12	0.0	CO(NH ₂) ₂	40.98	1.21	CaSO ₄ ·2H ₂ O
40.05	1.17	" + 4CO(NH ₂) ₂ ·CaSO ₄	39.78	1.02	"
38.91	1.14	4CO(NH ₂) ₂ ·CaSO ₄	38.86	0.76	"
35.51	1.31	" + CaSO ₄ ·2H ₂ O	34.01	0.88	"
30.57	0.87	CaSO ₄ ·2H ₂ O	15.05	0.35	"
24.35	0.71	"	14.35	0.35	"
0.0	0.17	"	0.0	0.21	"
Results at 20°			Results at 40°		
51.15	0.0	CO(NH ₂) ₂	63.32	0.0	CO(NH ₂) ₂
51.43	1.09	" + 4CO(NH ₂) ₂ ·CaSO ₄	62.47	1.14	" + 4CO(NH ₂) ₂ ·CaSO ₄
51.30	1.05	4CO(NH ₂) ₂ ·CaSO ₄	61.70	1.20	4CO(NH ₂) ₂ ·CaSO ₄
51.10	1.14	"	58.61	1.22	"
49.29	1.17	"	57.2	1.40	" + CaSO ₄ ·2H ₂ O
46.44	1.23	" + CaSO ₄ ·2H ₂ O	53.48	1.27	CaSO ₄ ·4H ₂ O
44.28	1.03	CaSO ₄ ·2H ₂ O	51.96	1.20	"
39.66	0.93	"	49.77	1.08	"
36.63	0.75	"	42.80	0.83	"
30.82	0.63	"	23.33	0.35	"
19.98	0.46	"	0.0	0.24	"
0.0	0.20	"			
Results at 30°			Results at 60°		
55.63	0.0	CO(NH ₂) ₂	76.03	0.0	CO(NH ₂) ₂
55.50	1.03	" + 4CO(NH ₂) ₂ ·CaSO ₄	76.27	1.37	" + 4CO(NH ₂) ₂ ·CaSO ₄
55.30	1.08	4CO(NH ₂) ₂ ·CaSO ₄	75.04	1.29	4CO(NH ₂) ₂ ·CaSO ₄
55.31	1.09	"	71.5	1.78	" + CaSO ₄ ·2H ₂ O
50.86	1.37	4CO(NH ₂) ₂ ·CaSO ₄ ·2H ₂ O	56.34	1.23	CaSO ₄ ·2H ₂ O
			41.36	0.60	"
			0.0	0.30	"

(Cont.)

THE SYSTEM CALCIUM SULFATE - UREA - WATER--Cont.

(Data of Sakai, 1940, 1943)

The results differ considerably from those of Uno (above). Each figure is the average of several determinations.

Results at 25° Gms. per 100 gms. sat. sol.		Results at 30° Gms. per 100 gms. sat. sol.		Solid Phase
CO(NH ₂) ₂	CaSO ₄	CO(NH ₂) ₂	CaSO ₄	
54.5	0.0	57.3	0.0	CO(NH ₂) ₂
55.8	1.1	61.4	1.2	CO(NH ₂) ₂ + 4CO(NH ₂) ₂ .CaSO ₄
51.5	1.4	55.5	1.2	4CO(NH ₂) ₂ .CaSO ₄ + CaSO ₄ .2H ₂ O

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SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF
METHYL, ETHYL AND n PROPYL ALCOHOL AT 25°
(Yamamoto, 1930)

Results for:

Methyl Alcohol		Ethyl Alcohol		<u>n</u> Propyl Alcohol	
Wt. percent CH ₃ OH in solvent	Gms. CaSO ₄ per 100 gms. sat. sol.	Wt. percent C ₂ H ₅ OH in solvent	Gms. CaSO ₄ per 100 gms. sat. sol.	Wt. percent C ₃ H ₇ OH in solvent	Gms. CaSO ₄ per 100 gms. sat. sol.
5.116	0.1304	0.0 (=H ₂ O)	0.2084	5.13	0.1174
10.25	0.0781	3.906	0.1314	10.21	0.0648
15.25	0.0496	6.221	0.0998	15.56	0.0379
20.5	0.0306	(10.)	(0.0970)*	20.52	0.0246
23.0	0.0236	13.58	0.0436	25.71	0.0173
25.42	0.0190	19.78	0.0209	30.57	0.0127
29.12	0.0136	20.89	0.0185	36.52	0.0081
30.94	0.0118	23.77	0.0139	40.76	0.0063
36.0	0.0080	27.29	0.0093	45.73	0.0044
41.89	0.0049	28.66	0.0082		
45.05	0.0035	32.97	0.0052		
46.52	0.0030	35.69	0.0044		
		40.97	0.0029		

*Magnanini, 1901.

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM
BENZENE SULFONATE AT 25°
(Mameli, 1922)

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
C ₆ H ₅ SO ₃ Na	CaSO ₄	C ₆ H ₅ SO ₃ Na	CaSO ₄
0.2312	0.3144	1.0814	0.4930
0.3301	0.3430	1.7315	0.4930
0.7012	0.4350	2.3196	0.4930

Ca CALCIUM

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF
CALCIUM BENZENE SULFONATE
(Mameli, 1922)

	Results at 0°		Results at 25°		Results at 50°	
	Gms. per 100 cc. sat. sol.		Gms. per 100 cc. sat. sol.		Gms. per 100 cc. sat. sol.	
	$\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2$	CaSO_4	$\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2$	CaSO_4	$\text{Ca}(\text{C}_6\text{H}_5\text{SO}_3)_2$	CaSO_4
	0.6001	0.2351	0.3571	0.2665	0.2008	0.2580
	0.9501	0.2701	0.6473	0.3186	0.6504	0.3302
	1.3001	0.3011	1.0168	0.3321	1.0007	0.3610
30	1.6789	0.3011	1.3301	0.3429	1.3102	0.3700
	2.0213	0.3011	2.7493	0.3429	2.4101	0.3700

Data of Mameli (1922) in solutions saturated with calcium benzene sulfonate:

t°	0°	25°	37°	50°	70°	90°
Gms. CaSO_4 per 100 cc. sat. sol.	0.3011	0.3429	0.3660	0.3700	0.3575	0.3406

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS AND ALCOHOLIC
MONOPOTASSIUM TARTRATE SOLUTIONS AT 20°
(Magnanini, 1901)

Solvent	Gms. CaSO_4 per 100 Gms. Solution
Water	0.2238
Aq. N/200 $\text{KHC}_4\text{H}_4\text{O}_6$	0.2323
10% alcohol	0.0970
10% alcoholic N/200 $\text{KHC}_2\text{H}_4\text{O}_6$	0.0866
Aq. N/200 $\text{KHC}_2\text{H}_4\text{O}_6$ + 5% tartaric acid	0.2566
10% alc. N/400 $\text{KHC}_2\text{H}_4\text{O}_6$ + 5% tartaric acid	0.1086

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SUGAR SOLUTIONS
(Stolle, 1900)

Per cent Concentration of Sugar Solutions	Gms. CaSO_4 Dissolved by 1000 cc. of the Sugar Solutions at:					
	30°	40°	50°	60°	70°	80°
0	...	2.157	1.730	1.730	1.652	1.710
10	2.041	1.730	1.730	1.574	1.574	1.613
20	1.808	1.652	1.419	1.380	1.419	1.263
27	1.550	1.438	1.361	1.283	1.283	0.972
35	1.263	1.050	1.088	1.108	0.914	...
42	1.030	...	0.777	0.816	0.855	0.729
49	...	0.564	0.739	0.564	0.603	0.486
55	...	0.486	0.505	0.486	0.369	0.330

100 gms. glycerol of d_{15} 1.256 dissolve 5.17 gms. CaSO_4 at 15°-16°.
(Ossendowski, 1907).

100 gms. glycerol of d 1.114 dissolve 0.95 gm. CaSO_4 at ord. temp.
(Asselin, 1873).

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS
OF ALBUMIN AND GLOBULIN AT 25°
(Pauli and Stenzinger, 1929)

Solvent	Gms. CaSO ₄ per 100 gms. sat. sol.
Water	0.2094
Aq. 5% Seralbumin	0.2119
Aq. 5% Pseudoglobulin	0.2180
Aq. 5% Hemoglobulin	0.2196

SOLUBILITY OF CALCIUM SULFATE IN GLYCINE SOLUTIONS AT 25°
(Lee and Luh, 1948)

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The authors present data which is rather widely scattered when plotted on cross section paper. The following values were read from the curve and the estimated accuracy is ± 0.1 gms. CaSO₄.

Gms. Glycine per 1000 gms. H ₂ O	Gms. CaSO ₄ per 1000 gms. Sat. Sol.	Gms. Glycine per 1000 gms. H ₂ O	Gms. CaSO ₄ per 1000 gms. Sat. Sol.
0.0	2.1	40.0	3.9
5.0	2.3	45.0	4.2
10.0	2.5	50.0	4.5
15.0	2.7	55.0	4.8
20.0	2.9	60.0	5.2
25.0	3.2	65.0	5.5
30.0	3.4	70.0	5.9
35.0	3.7	75.0	6.2

Melting point data are given for the following systems:

CaSO₄ + NaCl (Bye and Kiehl, 1948)
 CaSO₄ + Na₂B₄O₇ (Zhilenko and Sverchkov, 1940)
 CaSO₄ + K₂SO₄ (Bellanca, 1942; Müller, 1910; Grahmann, 1913)
 CaSO₄ + Na₂SO₄ (Bellanca, 1942; Bredig, 1942; Müller, 1910; Calcagni and Mancini, 1910)
 CaSO₄ + Na₂SO₄ + K₂SO₄ (Bellanca, 1942)
 CaSO₄ + Li₂SO₄ (Müller, 1910; Plyushchev and Komissarova, 1952; Golybeva and Bergman, 1954)
 CaSO₄ + Rb₂SO₄ (Müller, 1910)
 CaSO₄ + MgSO₄ (Plyushchev and Markovskaya, 1954)
 CaSO₄ + MgSO₄ + Na₂SO₄ (Mukimov and Fillipova, 1949)
 CaSO₄ + MgSO₄ + K₂SO₄ (Mukimov, Krilova and Bergman, 1949)
 CaSO₄ + KCl (binary) (Bergman and Golubova, 1953)

CALCIUM THIOSULFATE CaS₂O₃

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SOLUBILITY OF CALCIUM THIOSULFATE IN WATER
(Silberman and Ivanov, 1946)

The authors' data were plotted, and the values at intergral temperatures read from the curve (The solubility is a linear function of temperature in the interval studied). The authors' original data is marked (*). The solid phase was CaS₂O₃·6H₂O throughout.

Ca CALCIUM

SOLUBILITY OF CALCIUM THIOSULFATE IN WATER--Cont.

t°	Gms. CaS ₂ O ₃ per 100 gms. Sat. Sol.	t°	Gms. CaS ₂ O ₃ per 100 gms. Sat. Sol.
0	25.75	20	33.05
5	27.60	25	34.90(34.7)*
*6	28.04	*25.5	34.88
9	28.84(29.4)	*29.9	36.77
10	29.40	30	36.75
*11.75	30.08	*34.5	38.48
15	31.25	35	38.60
*17.75	32.28	40	40.45

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*Kremann and Rodemund, 1914.

THE SYSTEM CaCl₂ - CaS₂O₃ - H₂O AT 25° (Silberman and Ivanov, 1946)

Gms. CaS ₂ O ₃ per 100 gms. Sat. Sol.	Gms. CaCl ₂ per 100 gms. Sat. Sol.	Solid Phase	Gms. CaS ₂ O ₃ per 100 gms. Sat. Sol.	Gms. CaCl ₂ per 100 gms. Sat. Sol.	Solid Phase
34.68	0.0	CaS ₂ O ₃ .6H ₂ O	8.33	31.10	CaS ₂ O ₃ .6H ₂ O
28.55	6.08	"	7.99	32.65	"
24.10	10.24	"	7.49	33.34	" + CaS ₂ O ₃ .H ₂ O
20.80	12.75	"	3.45	38.46	CaS ₂ O ₃ .H ₂ O
16.24	17.16	"	1.43	42.30	"
14.20	19.75	"	1.32	43.16	"
13.88	20.76	"	1.03	45.01	" + CaCl ₂ .6H ₂ O
10.15	26.88	"	0.0	45.65	CaCl ₂ .6H ₂ O
9.21	29.68	"			

THE SYSTEM CaS₂O₃ + Na₂S₂O₃ + H₂O (Kremann and Rodemund, 1914)

Results at 9°			Results at 25°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Na ₂ S ₂ O ₃	CaS ₂ O ₃		Na ₂ S ₂ O ₃	CaS ₂ O ₃	
0	29.4	CaS ₂ O ₃ .6H ₂ O	0	34.7	CaS ₂ O ₃ .6H ₂ O
11.04	22.64	"	9.24	29.69	"
25.21	15.84	" + Na ₂ S ₂ O ₃ .5H ₂ O	15.67	21.41	"
31.01	7.70	Na ₂ S ₂ O ₃ .5H ₂ O	18.34	25.18	"
			28.24	21.14	"
			30.19	20.33	" + Na ₂ S ₂ O ₃ .5H ₂ O
			31.24	18.43	Na ₂ S ₂ O ₃ .5H ₂ O
			35.04	11.61	"

Data are also given for the quaternary systems, CaS₂O₃ + Na₂S₂O₃ + NaNO₃ + H₂O and CaS₂O₃ + Ca(NO₃)₂ + NaNO₃ + H₂O at 9° and 25°. A triple salt of the composition CaNa₃(S₂O₃)₂NO₃.11H₂O was obtained.

CALCIUM DITHIONATE CaS_2O_4

SO

SOLUBILITY OF CALCIUM DITHIONATE IN:
(de Baat, 1926)

t°	Water		Aq. ethyl alcohol at 30°		
	Gms. CaS_2O_6 per 100 gms.		Gms. per 100 gms. sat. sol.		
	sat. sol.	Solid Phase	CaS_2O_6	$\text{C}_2\text{H}_5\text{OH}$	Solid Phase
0	13.80	$\text{CaS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$	12.55	16.50	$\text{CaS}_2\text{O}_6 \cdot 5\text{H}_2\text{O}$
12	17.63	"	3.31	40.39	"
20	20.25	"	1.39	50.96	"
30	23.29	"	0.11	73.08	"
			0.059	92.47	"

CALCIUM SULFAMATE $\text{Ca}(\text{SO}_3\text{NH}_2)_2$

SON

SOLUBILITY OF CALCIUM SULFAMATE IN WATER
(King and Hooper, 1941)

The transition temperature $\text{Ca}(\text{SO}_3\text{NH}_2)_2 \cdot 4\text{H}_2\text{O} \rightleftharpoons \text{Ca}(\text{SO}_3\text{NH}_2)_2 + 4\text{H}_2\text{O}$ was found by the intersection of the solubility curves and by cooling curve determinations to be $69.40^\circ \pm 0.05^\circ$.

t°	Gms. $\text{Ca}(\text{SO}_3\text{NH}_2)_2$ per 100 gms. H_2O	Solid Phase	t°	Gms. $\text{Ca}(\text{SO}_3\text{NH}_2)_2$ per 100 gms. H_2O	Solid Phase
0.0	56.48	$\text{Ca}(\text{SO}_3\text{NH}_2)_2 \cdot 4\text{H}_2\text{O}$	69.40	...	$\text{Ca}(\text{SO}_3\text{NH}_2)_2 \cdot 4\text{H}_2\text{O} +$
10.0	62.76	"			$\text{Ca}(\text{SO}_3\text{NH}_2)_2$
20.0	72.32	"	71.0	205.0	$\text{Ca}(\text{SO}_3\text{NH}_2)_2$
*25.0	78.0	"	72.5	206.7	"
30.0	84.47	"	75.0	208.7	"
40.0	100.1	"	80.0	215.2	"
50.0	120.3	"	83.4	220.4	"
60.0	150.0	"	88.7	229.3	"
65.0	173.5	"	95.0	242.7	"
68.0	191.8	"			

*Interpolated. Cupery (1938) found the solubility to be 67 gms. per 100 gms. of water at 25° .

CALCIUM SELENATE CaSeO_4

SeO

SOLUBILITY OF CALCIUM SELENATE IN WATER
(Mayer and Aulich, 1928)

Although there is a sharp break in the curve at 18° , no change in the solid phase was detected. A hemi-hydrate of calcium selenate was prepared by boiling the dihydrate with glacial acetic acid for 6 hours.

Ca CALCIUM

SOLUBILITY OF CALCIUM SELENATE IN WATER--Cont.

t°	Gms. CaSeO ₄ per 100 gms. sat. sol.	Gm. mols. CaSeO ₄ per 100 mols. H ₂ O	Solid Phase
0	7.52	7.99	CaSeO ₄ .2H ₂ O
10	7.55*	8.03	"
15	7.63	8.12	"
18	7.65	8.15	"
21	7.15	7.57	"
25	6.88	7.26	"
30	6.84	7.22	"
35	6.81	7.18	"
SeO 40	6.26	6.57	"
50	5.89	6.15	"
60	5.63	5.85	"
100.5 (b. pt.)		..	"

*Dolique (1943) reports 6.12 gms. CaSeO₄ per 100 ml. H₂O at 10°

THE SYSTEM CALCIUM SELENATE - POTASSIUM SELENATE - WATER AT 25°
(Meyer and Aulich, 1928)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
K ₂ SeO ₄	CaSeO ₄		K ₂ SeO ₄	CaSeO ₄	
0.0	6.88	CaSeO ₄ .H ₂ O	26.18	5.78	CaSeO ₄ .2H ₂ O
13.62	6.67	"	31.52	5.26	" + CaK ₂ (SeO ₄) ₂ .2H ₂ O
16.43	6.42	"	35.42	3.24	CaK ₂ (SeO ₄) ₂ .2H ₂ O
17.90	6.22	"	43.05	1.12	" + K ₂ SeO ₄
19.29	5.56	"	53.3	0.0	K ₂ SeO ₄

THE SYSTEM CALCIUM SELENATE - AMMONIUM SELENATE - WATER AT 30°
(Welton and King, 1939)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
(NH ₄) ₂ SeO ₄	CaSeO ₄		(NH ₄) ₂ SeO ₄	CaSeO ₄	
0.0	6.84	CaSeO ₄ .2H ₂ O	39.89	3.53	CaSeO ₄ .2H ₂ O
4.59	6.70	"	45.21	2.95	"
10.45	6.26	"	49.17	2.74	"
12.89	6.17	"	50.99	2.37	"
16.50	5.83	"	52.31	2.28	"
20.64	5.51	"	53.74	2.10	" + (NH ₄) ₂ SeO ₄
25.09	5.22	"	54.47	1.06	(NH ₄) ₂ SeO ₄
28.07	4.94	"	54.69	0.36	"
34.51	4.14	"	55.18	0.0	"

THE SYSTEM CALCIUM SELENATE - SODIUM SELENATE - WATER AT 25°
(Meyer and Aulich, 1928)

Gms. per 100 gms. sat. sol.		Solid Phase
Na ₂ SeO ₄	CaSeO ₄	
0.0	6.88	CaSeO ₄ .2H ₂ O
10.55	5.77	"
16.17	4.94	"
17.51	4.79	"
20.59	4.25	"
27.98	3.33	CaSeO ₄ .2H ₂ O + CaNa ₂ (SeO ₄) ₂ .2H ₂ O
30.01	2.86	CaNa ₂ (SeO ₄) ₂ .2H ₂ O
33.62	2.32	"
35.61	2.17	" + Na ₂ SeO ₄
36.4	0.0	Na ₂ SeO ₄

CALCIUM SILICATE CaSiO₃

SiO

A STUDY OF THE SYSTEM CALCIUM OXIDE, SILICA AND WATER AT 30°
(Flint and Wells, 1934)

Silica gel was purified by boiling in concentrated HNO₃, followed by washing and electrolysis. An excess of it boiled with dilute solutions of calcium hydroxide for several days, produced solutions generally containing 0.4 to 0.5 gm. SiO₂ and 0.02 to 0.05 gm. CaO per liter. On cooling, they assume a light blue color, evidently due to a decreased solubility of silica at the lower temperature. Such sols are very stable. Precipitation of this colloidal silica can be very readily accomplished by addition of a small quantity of saturated calcium hydroxide solution. Although the initial sol containing solutions, when examined under the microscope, contain myriads of particles in Brownian movement, no trace of such movement can be detected in the clear solution after precipitation. It was assumed, therefore, that the latter are true solutions saturated with respect to silica at definite concentrations of calcium hydroxide. To investigate the solubility relationships of silica to lime, a large quantity of the sol containing solution was prepared and this mixed in various proportions with calcium hydroxide solution. The mixtures were placed in a thermostat at 30°. After one month the solutions were filtered and analyzed for silica and lime. The proportion of the lime to the silica in the precipitates was calculated by difference. The table of results shows the composition of the original mixtures and the ratio of CaO to SiO₂ in the precipitates and solutions with which they were in contact. Electrometric and analytical determinations showed the solid phases to be hydrated calcium salts of ortho silicic acid. Their solubilities are represented graphically. From the hydrolysis constants of these salts, ionization in the four steps in the dissociation of ortho silicic acid were calculated. Mono calcium silicate differs from the more basic calcium silicates in that it forms stable solutions and hence is nonhydraulic. The authors also studied the reaction of water upon portland cement and the reaction between diatomaceous silica and lime solution.

(Cont.)

Ca CALCIUM

A STUDY OF THE SYSTEM CALCIUM OXIDE, SILICA AND WATER AT 30°--Cont.

Results of Roller and Erwin, 1940 at 30.2°

The authors found that equilibrium could be attained in from 3 hours to 2 days when varying concentrations of lime water were added to a hydrous Calcium Silicate Precipitate. Equilibrium was approached from both undersaturation and supersaturation, and separate analyses were made for CaO and SiO₂ on the solid and the solution. The reagents were pure and free of CO₂. Data are given for the concentration of Calcium in equilibrium with solids of varying CaO/SiO₂ ratios, and two solutions of invariant composition were found. The nature of the solid phases were determined by assuming that the varying composition of the solids was due to the absorption of CaO from the solution by certain definite compounds of CaO + SiO₂ in the solid, and not just solid solutions CaO.ySiO₂. When various compounds were assumed as the absorbant and the moles CaO absorbed per mole of compound were plotted for different solutions, it was found that straight lines (Freundlich equation curves) were obtained for the compounds CaO.SiO₂ and 3CaO.4SiO₂. The existence of these compounds did not exclude the possibility of others, but their existence was confirmed by testing the product of their ionic concentrations, or activities, for constancy. By this means the formulas were found to be CaH₂SiO₄ and Ca₃(HSi₂O₆)₂, and in the latter case only the dimeric HSi₂O₆²⁻ was possible. The solubility products and ionization constants were calculated. The authors refer to other work on the system which supports their work.

Millimols Ca ⁺⁺ per liter	Moles CaO Moles SiO ₂	Solid Phase	Millimols Ca ⁺⁺ per liter	Moles CaO Moles SiO ₂	Solid Phase
20.67	1.401	CaH ₂ SiO ₄ (+ Absorbed CaO)	2.84	0.955	Ca ₃ (HSi ₂ O ₆) ₂ (+ Absorbed CaO)
19.96	1.447	"	2.69	.957	"
19.90	1.417	"	2.57	.955	"
19.60	1.427	"	2.24	.964	"
17.51	1.387	"	2.09	.936	"
14.98	1.326	"	2.07	.933	"
13.53	1.309	"	1.64	.910	"
12.08	1.267	"	1.60	.918	"
9.81	1.235	"	1.60	.919	"
7.49	1.187	"	1.37	.921	"
6.99	1.168	"	1.18	.901	"
6.60	1.164	"	0.990	.895	Ca ₃ (HSi ₂ O ₆) ₂ + CaO.2SiO ₂ .H ₂ O
4.89	1.116	"			
4.02	1.110	"	.897	.869	"
3.11	1.053	CaH ₂ SiO ₄ + Ca ₃ (HSi ₂ O ₆) ₂	.923	.854	"
		"	.900	.852	"
3.10	1.048	"	.900	.819	"
3.05	1.008	"	Av. .900	(0.931 SiO ₂)	"
3.11	1.014	"			
3.07	1.000	"			
Av. 3.09	(0.090 SiO ₂)	"			

Bassey, 1938 discusses the system CaO-SiO₂-H₂O and gives a summary of the known hydrates of Calcium Silicate. The discussion is continued by Cirilli, 1939. A more recent review, together with new hydrothermal studies is given by Taylor and Bessey, 1950.

A STUDY OF THE SYSTEM CALCIUM OXIDE, SILICA AND WATER AT 30°--Cont.

Krasilnikov and Kiselev, 1944 studied the absorption of CaO on Silica Gel and allowed up to 17 months for equilibrium. They concluded that absorption took place at first, and that the compound $\text{CaO} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$ was formed. This agrees with Roller and Ervin (above). Curves are given and compared to those of other authors, but no numerical tables are included.

Kalousek (1944) studied the system $\text{Na}_2\text{O} - \text{CaO} - \text{SiO}_2 - \text{H}_2\text{O}$ in part at 25° and found the stable phases to be $\text{Ca}(\text{OH})_2$ and a quaternary soda - lime - silica gel.

SOLUBILITY OF CALCIUM SILICATE IN WATER AND AQUEOUS
SUGAR SOLUTIONS AT 17°
(Weisberg, 1896)

SiO

The sample of calcium silicate was air dried.

Solvent	Grams per 100 cc. Saturated Solution			
	At 17°		After Boiling and Filtering Hot	
	CaO(det.)	CaSiO ₃ (calc.)	CaO(det.)	CaSiO ₃ (calc.)
Water	0.0046	0.0095	....	....
10% sugar sol.	0.0065	0.0135	0.0094	0.0195
20% sugar sol.	0.0076	0.0157	0.0120	0.0249

Melting point relationships have been determined for:

CaSiO ₃ + CaS	(Lebedew, 1911)
" + CaTiO ₃	(Smolensky, 1911-12)
" + Li ₂ SiO ₃	(Wallace, 1909)
" + MgSiO ₃	(Allen and White, 1911; Ginsberg, 1906)
" + MnSiO ₃	(Ginsberg, 1908, 1909)
" + Na ₂ SiO ₃	(Wallace, 1909; Kultascheff, 1903)
CaAl ₂ SiO ₇ + NaAlSiO ₄	(Smalley, 1947)
CaSiO ₃ + NaSiO ₃ + NaAlSiO ₄	(Spivak, 1944)
CaSiO ₃ + CaAlSi ₂ O ₈ + NaAlSiO ₄	(Gummer, 1943)
CaSiO ₃ + NaAlSi ₃ O ₈ + NaAlSiO ₄	(Foster, 1942)
CaSiO ₃ + Diopside + Anorthite	(Osborn, 1942)
CaSiO ₃ + Diopside	(Schairer and Bowen, 1942)
CaSiO ₃ + Akermanite	(" " " ")

CALCIUM TUNGSTATE CaWO₄

WO

At 25°, 0.0323 gms. CaWO₄ are dissolved in one liter of a saturated solution in water. (Berkem, 1943). This agrees with the value 0.0268 gms. per liter at 18°, previously reported. Both values obtained from conductivity measurements.

Cd CADMIUM

Cb COLUMBIUM COMPOUNDS

See Niobium.

Cd CADMIUM Cd

The solubilities of Cadmium and other metals in mixtures of their molten salts have been determined for the following:

Cd in CdCl_2 at 700° (11); Melting point data (12) (13) (14)

Cd in KCl (0.042 wt. %) at 700° (11)

Cd in NaCl at 700° (11)

Cd in $\text{CdCl}_2 + \text{KCl}$ at 700° (11)

Cd + Pb in $\text{CdCl}_2 + \text{PbCl}_2$ at 600° (1) (4) (5)

Cd + Pb in $\text{CdI}_2 + \text{PbI}_2$ at 500° (1)

Cd + Pb in $\text{CdBr}_2 + \text{PbBr}_2$ at 600° (1) (3)

Cd + Pb in $\text{CdBr}_2 + \text{PbBr}_2$ at 360° in mixtures of $\text{AlBr}_3 + \text{KBr}$ (2)

Cd + Sn in $\text{CdBr}_2 + \text{SnBr}_2$ at 360° in mixtures of $\text{AlBr}_3 + \text{KBr}$ (2) (6)

Cd + Sn in $\text{CdCl}_2 + \text{SnCl}_2$ at 600° (7) (8)

Cd + Tl in $\text{CdCl}_2 + \text{Tl}_2\text{Cl}_2$ at 460° and 600° (10)

Cd + Zn in $\text{CdCl}_2 + \text{ZnCl}_2$ at 500° and 600° (9)

Cd + Zn in $\text{CdBr}_2 + \text{ZnBr}_2$ at 450° and 550° (9)

(1) Hewsky and Jellinek (1933), (2) Delimarskii (1941), (3) Lorenz and Hering (1928), (4) Lorenz, Fraenkel, and Silberstein (1923), (5) Korber and Oelsen (1932), (6) Delimarskii and Miroshnichenko (1940), (7) Fraenkel, and Wolff (1928), (8) Lorenz (1924), (9) Jellinek and Siewers (1932), (10) Lorenz, Fraenkel, and Silberstein (1924), (11) Karpachev and Stromberg (1939), (12) Urazov and Karnavkhov (1954), (13) Grjotheim, Gronvold and Kroghmo (1955), (14) Cubicciotti (1952).

BO CADMIUM BORATE

Melting point data for the system $\text{CdO} + \text{B}_2\text{O}_3$ are given by Mazzetti and De Carli, 1926.

SOLUBILITY OF CADMIUM BROMIDE IN WATER

(Hering, 1936; above 100° Benrath, Ojedebo, Schiffers and Wunderlich, 1937; Benrath, 1941)

Previous results in fair agreement with these are given by Dietz, 1899, 1900, and by Ishikawa and Ueda, 1930, 1933.

t°	d. of sat. sol.	Gms. CdBr_2 per 100 gms. sat. sol.		Solid Phase	t°	Gms. CdBr_2 per 100 gms. sat. sol.		Solid Phase
		sat. sol.	sol.			sat. sol.	sol.	
-4.4	-	32.9		Ice + $\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$	153	64.6		CdBr_2
0	1.444	36.0		$\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$	174	66.5		"
+5	-	39.8		"	185	67.2		"
10	-	43.0		"	196	68.0		"
15	-	46.4		"	210	69.1		"
18	1.683	48.9		"	218	70.1		"
20	-	49.7		"	237	71.8		"
25	1.775	52.9		"	248	72.5		"
30	-	56.3		"	269	75.0		"
32.5	1.904	57.85		"	290	77.5		"
36.0	1.974	60.3		" + CaBr_2	312	79.2		"
38	1.971	60.3		CaBr_2	350	82.9		"
45	-	60.35		"	419	89.2		"
60	1.949	60.45		"	567 m.p.	100.0		"
75	1.938	60.8		"				
100	1.928	61.65		"				

EQUILIBRIUM IN THE SYSTEM CADMIUM BROMIDE - CADMIUM CHLORIDE - WATER
(Benrath and Lechner, 1940)

At different temperatures and compositions, the solid solution between the salts had different degrees of hydration. These were 0, 1, 5/2, and 4 mols. of water per mol. of salts. There is no solution at any temperature which is simultaneously saturated with both the 0 and 5/2 hydrated solid solutions, but all the other possible pairs may coexist under the proper conditions.

x = Mols. CdBr_2 per mol. of water free salt mixture
m = Mols. H_2O per mol. of water free salt mixture

Solution					Solid		
Wt. % CdCl_2	Wt. % CdBr_2	x	m	Density	x	m	Composition
Results at 25°							
54.9	0.0	0.0	8.37	1.787	-	-	$\text{CdCl}_2 \cdot 5\text{H}_2\text{O}$
54.2	1.24	1.51	8.25	1.800	0.33	2.87	S.S. $\cdot \frac{1}{2}\text{H}_2\text{O}$
51.7	4.78	5.86	8.07	1.843	1.70	2.44	"
44.4	14.07	177.60	7.86	1.903	14.81	4.01	"

(Cont.)

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Cd CADMIUM

Solution						Solid	
Wt. % CdCl ₂	Wt. % CdBr ₂	x	m	Density	x	m	Composition
40.6	18.49	23.5	7.86	1.922	18.92	3.70	S.S.· $\frac{3}{2}$ H ₂ O
-	-	26.0	7.9	-	-	-	S.S.· $\frac{3}{2}$ H ₂ O + S.S.·4H ₂ O
32.7	26.5	35.2	8.22	1.938	37.7	3.96	S.S.·4H ₂ O
26.3	32.5	45.4	8.74	1.934	47.5	4.74	"
14.56	43.4	66.0	10.31	1.902	71.1	4.00	"
6.78	47.9	82.6	11.80	1.838	90.0	4.98	"
3.26	50.8	91.3	12.51	1.810	96.6	4.94	"
0.0	52.9	100.0	13.50	1.785	-	-	CdBr ₂ ·4H ₂ O
Br							
Results at 30°							
56.2	0.0	0.0	7.95	1.827	-	-	CdCl ₂ ·5H ₂ O
51.9	5.57	6.74	7.79	1.857	0.61	2.59	S.S.· $\frac{3}{2}$ H ₂ O
52.7	6.42	7.58	7.31	1.915	4.24	2.00	"
47.6	11.74	14.24	7.46	1.939	13.45	2.95	"
44.2	15.70	19.31	7.47	1.966	17.92	2.66	"
-	-	31.0	7.50	-	-	-	S.S.· $\frac{3}{2}$ H ₂ O + S.S.·4H ₂ O
35.2	25.9	33.1	7.55	1.992	30.4	2.86	S.S.·4H ₂ O
30.3	30.4	40.3	7.88	1.994	46.3	3.23	"
24.2	36.0	50.0	8.36	1.981	57.2	3.23	"
18.51	41.1	59.9	8.91	1.988	66.7	3.32	"
16.09	43.4	64.5	9.09	1.981	69.0	3.17	"
13.36	46.2	70.0	9.27	1.979	73.2	3.02	"
10.20	49.2	76.4	9.56	1.975	86.5	3.32	"
6.65	51.9	84.0	10.17	1.945	91.4	5.07	"
4.63	53.3	88.6	10.58	1.927	97.2	4.22	"
0.0	56.2	100	11.80	1.873	-	-	CdBr ₂ ·4H ₂ O
Results at 35°							
57.3	0.0	0.0	7.59	1.858	-	-	CdCl ₂ ·H ₂ O
55.4	2.51	2.96	7.51	1.877	1.54	1.34	S.S.·H ₂ O
52.1	6.73	8.00	7.42	1.816	4.23	1.57	"
47.4	12.44	14.87	7.27	1.951	12.16	1.45	"
44.2	15.92	19.51	7.39	1.964	18.37	1.44	"
39.2	22.0	27.4	7.32	1.979	29.1	1.86	"
33.8	28.1	35.9	7.36	2.018	38.4	1.88	*S.S.·H ₂ O + S.S.·4H ₂ O
30.9	30.9	40.2	7.51	2.032	41.9	3.40	S.S.·4H ₂ O
27.5	34.5	50.2	7.64	2.036	52.5	2.54	"
20.9	41.5	57.2	7.85	2.042	67.1	1.76	"
15.88	46.2	66.2	8.23	2.031	67.4	3.17	"
15.22	46.3	67.2	8.44	2.031	70.4	3.42	"
12.75	48.8	72.1	8.59	2.016	75.0	3.09	"
12.24	48.9	72.9	8.77	2.022	78.5	2.26	"
9.39	51.6	78.7	9.01	2.017	87.0	2.87	"
6.66	54.0	84.5	9.31	2.013	87.4	4.02	"
4.60	55.9	89.1	9.53	2.002	91.4	2.66	"
3.27	57.1	92.2	9.67	1.992	95.4	4.37	"
0.0	59.2	100	10.43	1.966	-	-	CdBr ₂ ·4H ₂ O

*(plus anhydrous solid solution (?))

Solution					Solid		
Wt. % CdCl ₂	Wt. % CdBr ₂	x	m	Density	x	m	Composition
Results at 50°							
57.2	0.0	0.0	7.66	1.853	-	-	CdCl ₂ ·H ₂ O
53.6	4.88	5.77	7.40	1.901	0.26	2.67	S.S.·H ₂ O
48.6	9.64	11.79	7.32	1.936	9.88	2.56	"
46.1	14.25	17.24	7.26	1.968	16.43	2.40	"
38.9	22.4	27.9	7.31	2.004	23.2	2.83	"
36.5	25.2	31.7	7.30	2.029	29.1	2.89	"
30.4	31.0	41.5	7.40	2.048	33.6	3.01	"
-	-	43.0	7.45	-	-	-	S.S.·H ₂ O + S. S.
27.5	34.7	45.9	7.56	-	47.7	3.14	Solid Solution
27.5	35.0	46.1	7.48	-	48.2	2.83	"
24.8	37.7	50.2	7.61	2.058	52.8	2.48	"
16.24	45.7	65.5	8.23	2.078	70.5	2.75	"
11.84	50.3	74.1	8.42	2.061	78.4	2.74	"
10.68	50.0	76.8	8.68	2.055	83.2	3.60	"
8.98	52.6	79.8	8.83	2.054	94.7	2.74	"
5.67	55.5	86.8	9.18	2.040	88.2	2.59	"
0.0	60.8	0.0	9.74	2.047	-	-	CdBr ₂

Br

Results at 75°							
58.0	0.0	0.0	7.36	1.908	-	-	CdCl ₂ ·H ₂ O
56.9	1.64	1.90	7.28	1.926	0.0	2.12	S.S.·H ₂ O
52.5	7.14	8.42	7.15	1.980	4.15	1.62	"
50.7	9.44	11.13	7.11	1.983	8.74	2.70	"
42.3	19.41	23.6	7.04	2.043	19.02	2.42	"
39.4	22.9	28.2	7.00	2.053	23.2	2.55	"
37.1	25.5	31.7	7.04	2.078	25.0	2.36	"
30.2	33.5	42.8	7.03	2.110	41.7	2.46	"
24.7	39.2	51.7	7.21	2.119	51.2	2.46	S.S.·H ₂ O + S.S.
22.1	41.5	55.8	7.41	2.128	61.3	2.04	Solid Solution
21.6	41.9	56.7	7.47	2.134	57.8	1.84	"
19.13	44.6	61.1	7.53	2.134	69.0	1.75	"
14.80	48.6	68.9	7.84	2.133	70.7	2.73	"
11.97	51.3	74.3	8.03	2.126	77.2	2.96	"
10.50	52.6	77.1	8.19	2.127	84.1	2.01	"
8.18	53.6	81.7	8.70	2.081	89.5	2.77	"
3.68	58.0	91.4	9.13	2.077	90.4	1.53	"
1.28	60.2	96.9	9.39	2.052	94.7	1.67	"
0.0	61.2	0.0	9.57	2.047	-	-	CdBr ₂

Results at 100°							
59.2	0.0	0.0	7.00	1.993	-	-	CdCl ₂ ·H ₂ O
56.3	3.82	4.37	6.90	2.023	1.54	1.83	S.S.·H ₂ O
47.9	14.72	17.14	6.58	2.095	12.23	1.78	"
40.3	23.4	28.1	6.59	2.151	19.54	1.86	"
34.0	30.9	38.0	6.53	2.185	36.2	1.62	"
28.2	37.3	47.1	6.59	2.217	45.1	1.58	"
24.4	43.1	54.4	6.72	2.214	56.7	2.09	"
-	-	59.0	6.8	-	-	-	S.S.·H ₂ O + S.S.

(Cont.)

Cd CADMIUM

Solution					Solid		
Wt. % CdCl ₂	Wt. % CdBr ₂	x	m	Density	x	m	Composition
Results at 100°-Contd.							
18.85	47.0	62.7	6.88	2.237	67.1	1.43	Solid Solution
16.94	48.4	65.8	7.11	2.230	77.6	1.83	"
8.75	54.8	80.9	8.11	2.177	87.2	0.71	"
5.26	57.2	88.0	8.75	2.150	92.9	0.62	"
0.0	61.4	100	9.50	2.110	-	-	CdBr ₂

Br

EQUILIBRIUM IN THE SYSTEM CADMIUM BROMIDE, POTASSIUM BROMIDE AND WATER
(Hering, 1936)

The author determined a large number of isotherms and by plotting these results ascertained the limits of existence of the several double salts. Cryoscopic data in the system are also given by Cornec and Urbain, 1919.

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CdBr ₂	KBr				CdBr ₂	KBr	
-2.7	13.9	6.1	Ice	0	1.585	37.9	7.7	CdBr ₂ ·4H ₂ O
-3.7	12.4	10.9	Ice	0	1.708	34.1	20.2	1.1.1
-4.5	12.0	13.7	"	0	1.989	33.5	35.1	"
-5.1	24.4	10.6	"	0	1.669	21.0	34.6	KBr
-7.6	22.4	19.5	"	0	1.502	12.25	34.45	"
-9.2	34.8	15.2	"	-9.4	-	35.5	14.8	Ice + CdBr ₂ ·4 H ₂ O + 1.1.1
-10.1	21.8	24.7	"	0	1.744	40.0	14.1	CdBr ₂ ·4H ₂ O + 1.1.1
-12.0	29.0	25.4	"	-18.1	-	29.0	33.0	Ice + KBr + 1.1.1
-16.8	28.1	32.0	"	9	2.011	33.7	35.7	KBr + 1.1.1

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdBr ₂	KBr	
6.5	1.805	43.2	13.45	Cd ₄ + 1.1.1
12.	2.108	36.0	37.1	KBr + 1.1.1
13.0	1.872	46.4	12.75	Cd ₄ + 1.1.1
15.2	1.896	47.5	12.6	Cd ₄ + 3.1.4 + 1.1.1
18.	1.901	48.8	11.05	Cd ₄ + 3.1.4
18.	1.911	47.8	12.9	3.1.4 + 1.1.1
20.	2.163	37.5	37.6	KBr + 1.1.1
22.9	2.185	38.3	37.7	" + " + 1.1
25.0	2.194	38.3	37.9	" + " "
25	1.892	52.6	6.0	Cd ₄
25	1.928	51.0	9.7	3.1.4
25	1.936	49.7	11.8	"
25	1.869	37.8	25.0	1.1.1
25	2.093	37.3	35.5	"

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdBr ₂	KBr	
25	1.717	21.4	37.9	KBr
25	1.527	10.65	39.05	"
25	1.929	52.7	7.5	Cd4 + 3.1.4
25	1.947	48.7	13.7	3.1.4 + 1.1.1
32.5	2.001	57.6	4.5	Cd4 + 3.1.4
35.	2.031	59.2	3.7	Cd4 + Cd + 3.1.4
35	2.007	50.0	15.0	3.1.4 + 1.1.1
37	2.035	58.9	4.3	Cd4 + 3.1.4
45	2.056	57.7	7.05	" + "
45	2.067	51.5	15.9	3.1.4 + 1.1.1
50	2.291	40.5	39.2	KBr + 1.1
50	2.099	52.2	16.4	3.1.4 + 1.1.1
52.1	2.111	52.5	16.6	" + " + 2.1.1
52.5	2.092	56.6	10.35	Cd4 + 3.1.4
54.5	2.088	56.8	10.2	Cd
56	2.119	52.6	16.9	2.1.1
56	2.116	55.8	12.5	Cd + 3.1.4
56	2.123	54.6	14.4	3.1.4 + 2.1.1
56	2.117	51.8	18.0	2.1.1 + 1.1.1
56.7	2.118	51.7	18.25	" + " + 1.1
57.6	2.132	55.5	13.5	Cd + 3.1.4 + 2.1.1
60	2.138	55.2	14.3	Cd + 2.1.1
60	2.165	52.5	19.6	2.1.1 + 1.1
70	2.148	54.8	15.9	Cd
70	2.163	53.4	18.2	2.1.1
70	2.144	50.9	21.0	1.1.0
70	2.166	54.4	17.0	Cd + 2.1.1
70	2.165	52.5	19.6	2.1.1 + 1.1
75	2.373	42.4	40.1	KBr + 1.1
80	2.200	53.7	19.65	Cd + 2.1.1
86	2.224	53.5	21.1	" + " + 1.1
90	2.232	53.5	21.6	" + 1.1
100	2.257	53.4	23.1	" + "
100	1.998	58.3	7.0	Cd
100	2.106	55.3	15.2	Cd
100	2.446	44.1	40.9	KBr + 1.1.1
100	2.200	48.8	27.6	1.1
100	2.190	46.5	30.3	1.1
100	2.207	44.7	33.3	1.1
100	2.321	43.6	36.1	"
100	2.324	41.4	40.8	KBr
100	1.949	29.6	42.2	"
100	1.636	12.8	47.0	"
110	2.287	53.5	24.35	Cd + 1.1.1

Cd4 = CdBr₂·4H₂O; Cd = CdBr₂; 1.1.1 = CdBr₂·KBr·H₂O; 3.1.4 =
3CdBr₂·KBr·4H₂O; 2.1.1 = 2CdBr₂·KBr·H₂O; 1.1 = CdBr₂·KBr.

Cd CADMIUM

Br CADMIUM POTASSIUM BROMIDES

SOLUBILITY OF CADMIUM POTASSIUM BROMIDES IN WATER
(Hering, 1936)

t°	Gms. anhydrous d. of double salt sat. per 100 gms.			Solid Phase	t°	Gms. anhydrous d. of double salt sat. per 100 gms.			Solid Phase
	sol.	sat.	sol.			sol.	sat.	sol.	
25	-	60.25		3.1.4	45	2.003	66.75		1.1.1
35	1.968	63.2		"	55	2.064	69.15		"
45	2.001	64.9		"	57.3	2.077	69.6		" + 1.1
-9.3	-	50.2		Ice + 1.1.1	65	2.111	71.0		1.1
0	1.720	53.8		1.1.1	75	2.151	72.65		"
25	1.881	61.5		"	80	2.172	73.4		"
35	1.942	64.2		"	100	2.254	76.45		"

3.1.4 = $3\text{CdBr}_2 \cdot \text{KBr} \cdot 4\text{H}_2\text{O}$; 1.1.1 = $\text{CdBr}_2 \cdot \text{KBr} \cdot \text{H}_2\text{O}$; 1.1 = $\text{CdBr}_2 \cdot \text{KBr}$
Previous results for the compound 1.1.1 are given by Rimbach, 1905.

CADMIUM (Mono)AMMONIUM BROMIDE $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$ SOLUBILITY IN WATER
(Rimbach, 1950; Eder)

t°	100 Grams Solution contain Gms.			Atomic Relation			G. $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$ per 100 Gms. Solution
	Cd.	Br.	NH_4 .	Cd	: Br	: NH_4 .	
1.0	16.33	34.87	2.63	1	3	1	53.82
14.8	17.40	37.15	2.80	1	3	1	58.01
52.2	19.79	42.38	3.21	1	3	1	65.31
110.1	22.99	49.17	3.72	1	3	1	75.98

100 gms. H_2O saturated with $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$ dissolve 137 gms. of the salt; 100 gms. alcohol dissolve 18 gms. and 100 gms. ether dissolve 0.36 gm. (Eder, 1876)

CADMIUM (Tetra) AMMONIUM BROMIDE $\text{CdBr}_2 \cdot 4\text{NH}_4\text{Br}$ SOLUBILITY IN WATER
(Rimbach)

The double salt is decomposed by water at temperatures below 160°.

CADMIUM Cd

t°	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Atomic Relation in Solid		
	Cd	Br	NH ₄	Cd	Br	NH ₄	Cd	Br	NH ₄
0.8	14.72	50.46	6.67	1	4.82	2.82	1	10.02	8.02
13.0	14.95	51.48	6.85	1	4.85	2.85	1	11.57	9.57
44.0	15.01	53.85	7.35	1	5.04	3.04	1	6.84	4.84
76.4	14.6	55.28	7.80	1	5.32	3.32	1	6.63	4.63
123.5	15.5	59.50	8.45	1	5.38	3.38	1	7.40	5.40
160.0	14.7	62.67	9.43	1	5.99	3.99	1	6.03	4.03

CADMIUM (Mono)RUBIDIUM BROMIDE CdBr₂·RbBr

Br

SOLUBILITY IN WATER
(Rimbach)

t°	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Gms. CdBr ₂ ·RbBr per 100 Gms. Solution
	Cd	Br	Rb	Cd	Br	Rb	
0.4	8.37	17.93	6.43	1	3	1.01	32.65
14.5	10.72	23.02	8.30	0.99	3	1.01	41.87
49.2	15.01	32.13	11.51	1	3	1	58.54
107.5	19.65	41.12	14.06	1.02	3	0.96	75.77

CADMIUM (Tetra)RUBIDIUM BROMIDE CdBr₂·4RbBr

SOLUBILITY IN WATER
(Rimbach)

t°	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Gms. CdBr ₂ ·4RbBr per 100 Gms. Solution
	Cd	Br	Rb	Cd	Br	Rb	
0.5	5.70	24.94	17.97	0.98	6	4.05	47.95
13.5	6.55	28.74	20.74	0.97	6	4.05	55.17
51.5	8.25	35.51	25.39	0.99	6	4.02	68.82
114.5	9.50	40.67	29.00	1.00	6	4.0	79.04

CADMIUM (Mono) SODIUM BROMIDE CdBr₂·NaBr2½H₂O

SOLUBILITY IN WATER, Etc., at 15°
(Eder, 1876)

Solvent	Gms. CdBr ₂ NaBr per 100 Gms.		Solid Phase
	Solution	Solvent	
Water	49.0	96.1	CdBr ₂ ·NaBr·2½H ₂ O
Absolute Alcohol	21.2	27.0	"
Absolute Ether	0.52	0.53	"

Cd CADMIUM

SOLUBILITY OF ANHYDROUS CADMIUM BROMIDE IN PURE METHYL AND ETHYL ALCOHOLS

(Lloyd, Brown, Glynwyn, Bonnell and Jones, 1926)

Results for CH ₃ OH			Results for C ₂ H ₅ OH		
t°	Gms. CdBr ₂ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. CdBr ₂ per 100 gms. CH ₃ OH	Solid Phase
0	9.9	CdBr ₂ ·3CH ₃ OH	10	26.9	CdBr ₂ ·1½C ₂ H ₅ OH
15	13.5	"	20	30.0	"
20	16.2	"	30	33.5	"
25	18.4	"	40	37.8	"
Br 30	21.1	CdBr ₂ ·2CH ₃ OH	45	39.3	CdBr ₂
40	24.5	"	50	38.1	"
50	31.0	"	60	30.3	"
60	43.9	"	70	22.3	"

SOLUBILITY OF CADMIUM BROMIDE IN ALCOHOL, ETHER, ETC.

100 gms. sat. solution of CdBr₂·4H₂O in abs. alcohol contain 20.93 gms. CdBr₂ at 15°. (Eder)

100 gms. sat. solution of CdBr₂·4H₂O in abs. ether contain 0.4 gm. CdBr₂ at 15°. (Eder)

100 gms. absolute acetone dissolve 1.559 gms. CdBr₂ at 18°.

d₁₈ sat. sol. = 0.8073. (Neumann, 1904)

100 gms. benzonitrile dissolve 0.857 gm. CdBr₂ at 18°. (Neumann, 1914)

100 gms. anhydrous hydrazine dissolve 40 gm. CdBr₂ at room temp. (Welsh and Broderson, 1915)

Melting Point data are given for:

Cadmium Bromide	+	Cadmium Chloride	(Nacken, 1907; Ruff and Plato, 1903)
"	"	+ Cadmium Iodide	(Nacken, 1907)
"	"	+ Calcium Fluoride	(Ruff and Plato, 1903)
"	"	+ Cuprous Bromide	(Herrmann, 1911)
"	"	+ Potassium Bromide	(Brand, 1913)
"	"	+ Sodium Bromide	(")
"	"	+ " " + Potassium Bromide	(")
"	"	+ Thallium Nitrate	(Bergmann, 1926)
"	"	+ Zinc Bromide	(Zakharchenko, 1951)
"	"	+ Lead Bromide	(")
4	"	+ Silver Bromide	(")

Br CADMIUM Antipyrine BROMIDE Cd(C₁₁H₁₂N₂O)₂Br₂

(Data of Kumov, 1951)

At 15°	100 ml H ₂ O	dissolve	1.16 g	cadmium antipyrine bromide
"	100 ml C ₂ H ₅ OH	"	0.51 g	" " "
"	100 ml (C ₂ H ₅) ₂ O	"	0.076 g	" " "

CADMIUM FORMATE $\text{Cd}(\text{HCOO})_2$

CH

SOLUBILITY OF CADMIUM FORMATE IN WATER
(Ashton, Houston and Saylor, 1933)

t°	Gms. $\text{Cd}(\text{HCOO})_2$ per 100 gms. H_2O	Solid Phase	t°	Gms. $\text{Cd}(\text{HCOO})_2$ per 100 gms. H_2O	Solid Phase
0	8.4	$\text{Cd}(\text{HCOO})_2 \cdot \text{H}_2\text{O}$	60	59.5	$\text{Cd}(\text{HCOO})_2 \cdot 2\text{H}_2\text{O}$
10	11.1	"	66	75.5	"
20	14.4	"	70	77.0	$\text{Cd}(\text{HCOO})_2$
30	18.6	"	80	80.5	"
40	25.4	"	90	85.2	"
50	38.5	"	100	94.6	"

CADMIUM ACETATE $\text{Cd}(\text{CH}_3\text{COO})_2$

CH

SOLUBILITY OF CADMIUM ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°
(Cagle and Vosburgh, 1935)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CH_3COOH	$\text{Cd}(\text{CH}_3\text{COO})_2$		CH_3COOH	$\text{Cd}(\text{CH}_3\text{COO})_2$	
1.88	61.07	$\text{Cd}(\text{CH}_3\text{COO})_2 \cdot 2\text{H}_2\text{O}$	30.17	51.84	3.4.4
2.15	61.55	"	37.43	45.23	"
3.59	60.71	"	43.29	39.99	"
7.28	59.74	"	48.59	35.98	"
9.76	58.99	"	54.12	31.89	"
11.99	58.77	"	65.86	23.69	"
13.55	57.98	"	69.42	21.09	"
17.99	56.84	"	79.54	17.09	" + ?
23.35	55.50	"	90.22	7.87	?
25.48	55.31	"	95.04	4.20	?
27.34	55.26	" + 3.4.4	97.54	1.70	?

3.4.4 = $3\text{Cd}(\text{CH}_3\text{COO})_2 \cdot 4\text{CH}_3\text{COOH} \cdot 4\text{H}_2\text{O}$.

100 gms. methyl alcohol dissolve 21.08 gms. anhydrous $\text{Cd}(\text{CH}_3\text{COO})_2$ at 15° and 39.47 gms. at 68.9 (b. pt.). (Henstock, 1934)

Melting points in the system cadmium acetate-potassium acetate are given by Lehrman and Schweitzer, 1954.

CADMIUM TRIFLUORO ACETATE $\text{Cd}(\text{CF}_3\text{COO})_2$

7.61 gms. $\text{Cd}(\text{CF}_3\text{COO})_2$ dissolve in 100 gms. anhydrous CF_3COOH at 29.8°. The solid phase is unsolvated. (Hara and Cady, 1954)

Cd CADMIUM

CH CADMIUM FUMARATE $\text{CdC}_4\text{H}_2\text{O}_4$

100 gms. H_2O dissolve 0.09 gms. $\text{CdC}_4\text{H}_2\text{O}_4$ at 30° . (Weiss and Downes, 1923)

CADMIUM MALEATE $\text{CdC}_4\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

100 gms. H_2O dissolve 0.66 gms. $\text{CdC}_4\text{H}_2\text{O}_4$ at 30° . (Weiss and Downes, 1923)

CADMIUM BENZOATES

Solubility of Each in Water at 20° . (Ephraim and Pfister, 1925)

Salt	Formula	Gms. anhydrous salt per 100 gms. sat. sol.
Cadmium Benzoate	$(\text{C}_6\text{H}_5\text{COO})_2\text{Cd} \cdot 2\text{H}_2\text{O}$	3.340
" -4 Nitro Benzoate	$(\text{C}_7\text{H}_4\text{O}_4\text{N})_2\text{Cd} \cdot 2\text{H}_2\text{O}$	0.445
" -4 Chloro Benzoate	$(\text{C}_7\text{H}_4\text{O}_2\text{Cl})_2\text{Cd} \cdot 2\text{H}_2\text{O}$	0.779
" -4 Methoxy Benzoate	$(\text{C}_8\text{H}_7\text{O}_3)_2\text{Cd} \cdot \text{H}_2\text{O}$	0.402

CH CADMIUM CINNAMATES $(\text{C}_6\text{H}_5\text{CH}:\text{CH} \cdot \text{COO})_2\text{Cd}$

100 gms. water dissolve 0.070 gm. cadmium cinnamate at 26° . (de Jong, 1909)

100 gms. water dissolve 0.0374 gm. cadmium cinnamate at 20° . (Ephraim and Pfister, 1925)

100 gms. water dissolve 0.56 gm. cadmium isocinnamate at 20° . (Michael, 1903)

100 gms. water dissolve 0.10 gm. cadmium allocinnamate at 20° . (Michael, 1903)

CADMIUM Benzene Sulfonates

CADMIUM Anthracene Sulfonates

CADMIUM Naphthalene Sulfonates

SOLUBILITY OF EACH IN WATER

(Ephraim and Pfister, 1925; Ephraim and Seger, 1925)

Compound	Formula	t°	Gms. anhydrous cmpd. per 100 cc. sat. sol.
Cadmium anthracene-2-sulfonate	$\text{Cd}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	20	0.00925
" benzene sulfonate	$\text{Cd}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 7\text{H}_2\text{O}$	20	31.239
" " "	$\text{Cd}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	18	27.969
" " "	"	34	35.511
" " "	"	49.5	44.936
" " "	"	64.5	55.764
" " "	"	80.5	69.200

SOLUBILITY OF CADMIUM NAPHTHALENE SULFONATES IN WATER
(Ephraim and Pfister, 1924; Ephraim and Seger, 1925)

Compound				Formula	t°	Gms. Anhydrous compd. per 100 gms. sat. sol.
Cadmium naphthalene-1-sulfonate				$\text{Cd}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	17	4.508
"	"	-2-	"	"	16.5	0.872
"	"	-2-	"	"	20.0	0.696
"	"	"	"	"	32.0	1.033
"	"	"	"	"	45.0	1.550
"	"	"	"	"	54.5	2.085
"	"	"	"	"	65	2.925
"	"	"	"	"	69	3.407
"	"	"	"	"	78	5.061
"	"	"	"	"	82	5.799
Cadmium naphthalene-6-oxy-2-sulfonate				$\text{Cd}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	20	1.651

CADMIUM Anthraquinone SULFONATES

CN

SOLUBILITY OF EACH IN WATER AT 18°.
(Pierz-David, 1927)

Compound				Formula	Gms. anhydrous salt per 100cc. H ₂ O
Cadmium Anthraquinone	1.5	DiSulfonate		$\text{Cd}[\text{C}_{14}\text{H}_6\text{O}_2(\text{SO}_3)_2]_2 \cdot 7\text{H}_2\text{O}$	3.0
"	1.8	"		$\text{Cd}[\text{C}_{14}\text{H}_6\text{O}_2(\text{SO}_3)_2]_2 \cdot 5\text{H}_2\text{O}$	0.44

CADMIUM HELIANTHATE $(\text{C}_{14}\text{H}_{14}\text{N}_2\text{SO}_3)_2\text{Cd} \cdot 4\text{H}_2\text{O}$

1000 cc. H₂O dissolve 0.07 gms. $\text{C}_{14}\text{H}_{14}\text{N}_2\text{SO}_3$ in the form of cadmium helianthate at 20-25°. (Stark and Dehn, 1918)

CADMIUM Nitroso β Phenyl HYDROXYLAMINE. $\text{Cd}[\text{C}_6\text{H}_5 \cdot \text{N}(\text{NO}) \cdot \text{O}]_2$

One liter sat. solution of $\text{Cd}[\text{C}_6\text{H}_5 \cdot \text{N}(\text{NO})\text{O}]_2$ in water at 18° contains 0.00036 gm. atoms Cd (= 0.040 gm. Cd). (Pinkus and Martin, 1927)

CADMIUM PYRROLINE-RHODINATE $\text{Cd}(\text{CNS})(\text{C}_5\text{N}_5\text{N})?$

CH

4.58×10^{-3} moles are dissolved in one liter of a saturated solution in water. 3.22×10^{-3} moles are dissolved in one liter of a saturated solution in absolute alcohol (Probably at 20°). (Treadwell and Ammann, 1938)

Cd CADMIUM

CH CADMIUM DIPHENYL $\text{Cd}(\text{C}_6\text{H}_5)_2$

SOLUBILITY IN SEVERAL SOLVENTS AT 20°
(Strohmeier, 1955)

Solvent	$\text{Cd}(\text{C}_6\text{H}_5)_2$ per liter sat. sol.	
	Gms.	Moles
Heptane	0.37	0.0014
Benzene	16.	.06
Dioxane	427.	1.75
Ethyl Ether	60.5	0.22

CADMIUM CUPFERRATE $\text{Cd}(\text{C}_6\text{H}_5\text{N}(\text{NO})\text{O})_2$

5.46×10^{-3} moles are dissolved in one liter of a saturated solution in water which is 0.01 N with Acetic Acid (Probably at 20°). (Treadwell and Ammann, 1938)

CH CADMIUM ANTHRANILATE $\text{Cd}(\text{H}_2\text{HC}_6\text{H}_4\text{COO})_2$

0.0141 moles are dissolved in one liter of a saturated solution in water which is 1.0 N with Acetic Acid (Probably at 20°). (Treadwell and Ammann, 1938)

**CADMIUM 8-HYDROXYQUINOLATES $\text{Cd}(\text{C}_9\text{H}_6\text{ON})_2$
(oxyquinolate)
(oxine)**

0.0108 moles are dissolved in one liter of a saturated solution in water which is 1.0 N with Acetic Acid (Probably at 20°). (Treadwell and Ammann, 1938)

The Ksp is reported by Borrel and Paris, 1952 to be about 10^{-19} . The 2-methyl-8-hydroxyquinolate has a Ksp of about 2.5×10^{-20} (room temperature).

CADMIUM 8-HYDROXYQUINOLINE-5-SULFONATE $\text{Cd}(\text{C}_9\text{H}_6\text{ONS}_3)_2$

At 25° the Ksp of the normal salt is 2.5×10^{-11} . (Nasanen and Uusitalo, 1954)

CADMIUM 8-QUINOLINECARBOXYLATE $\text{Cd}(\text{C}_9\text{H}_6\text{NCOO})_2$

Data for the solubility in water and in KCl solutions is given by Lumme, 1955.

CADMIUM CYANIDE $\text{Cd}(\text{CN})_2$

CN

One liter sat. solution in water contains 1.51×10^{-5} gm. mols. (= 0.247 gm.) $\text{Cd}(\text{CN})_2$ at 18° determined by the potentiometric method. (Masaki, 1931)

THE SYSTEM CADMIUM CYANIDE-POTASSIUM CYANIDE-WATER AT 25°
(Corbet, 1926)

Note.—Saturation was secured by constant rotation in wax bottles for 1 or 2 days and then thoroughly grinding the solid and continuing the rotation for a further 4 or 5 days.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
KCN	$\text{Cd}(\text{CN})_2$	Solid Phase	KCN	$\text{Cd}(\text{CN})_2$	Solid Phase
41.7	0.0	KCN	11.65	16.15	$\text{K}_2\text{Cd}(\text{CN})_4$
40.67	0.82	$\text{K}_2\text{Cd}(\text{CN})_4$	9.47	19.14	" + $\text{Cd}(\text{CN})_2$
28.62	4.65	"	7.82	15.73	$\text{Cd}(\text{CN})_2^*$
17.79	10.70	"	4.68	10.21	" *
15.16	12.53	"	trace	0.36	" *

*The solid phase in these cases was undoubtedly a basic cadmium cyanide.

CADMIUM FERROCYANIDE $\text{Cd}_2\text{Fe}(\text{CN})_6$

CN

A saturated solution contains 6.4×10^{-6} moles Cd^{++} per liter. (Tananaev, Glushkova and Seifer, 1956)

CADMIUM FERRICYANIDE $\text{Cd}_3(\text{Fe}(\text{CN})_6)_2 \cdot n\text{H}_2\text{O}$

CN

SOLUBILITY OF CADMIUM FERRICYANIDE IN SALT SOLUTIONS
(King, 1949)

Total Cl ⁻ Moles per Liter	Moles $\text{Cd}_3(\text{Fe}(\text{CN})_6)_2$ per liter $\times 10^3$			Total Cl ⁻ Moles per Liter	Moles $\text{Cd}_3(\text{Fe}(\text{CN})_6)_2$ per liter $\times 10^3$		
	0°	25°	*47.5°		0°	25°	*47.5°
0.000	3.9	6.7	9.7	0.080	9.6	17.6	26.8
.018	-	-	13.6	.154	14.8 ^a	-	-
.020	5.2	8.7	-	.160	15.5	27.9	40.2
.036	-	-	16.3	.280	25.9	46.9	75
.040	6.7	10.8	-	.480	49.5	85.9	124.1
				.800	84	182	251

*In all 47.5° experiments $\text{H}^+ = 0.02 \text{ M}$
 $\text{Na}^+ = 2.98 \text{ M}$

^a($\text{H}^+ = 0.15 \text{ M}$ $\text{Na}^+ = 2.85 \text{ M}$)

Cd CADMIUM**CN CADMIUM NITROPRUSSIDE $\text{CdFe}(\text{CN})_5\text{NO}\cdot 2\text{H}_2\text{O}$**

One liter of sat. sol. at 18° contains 0.0003 mole $\text{CdFe}(\text{CN})_5\text{NO}$.
(Tomicek and Kubik, 1937)

CNS CADMIUM THIOCYANATE $\text{Cd}(\text{SCN})_2$

One liter sat. solution in water contains a 2.51×10^{-5} gm. mols.
 $\text{Cd}(\text{SCN})_2$ at 18° determined by the potentiometric method. (Masaki, 1931)

CADMIUM Mercuri THIOCYANATE $\text{Cd}[\text{Hg}(\text{SCN})_4]$

Straumanis and Stahl, 1943 studied the binary systems $[\text{Cd Hg}(\text{CNS})_4] + \text{Co}[\text{Hg}(\text{CNS})_4]$ and $\text{Cd}[\text{Hg}(\text{CNS})_4] + \text{Zn}[\text{Hg}(\text{CNS})_4]$. In 1944 the authors studied the ternary system $\text{Cd}[\text{Hg}(\text{CNS})_4] + \text{Co}[\text{Hg}(\text{CNS})_4] + \text{Zn}[\text{Hg}(\text{CNS})_4]$.

CADMIUM Antipyrine THIOCYANATE $\text{Cd}(\text{C}_{11}\text{H}_{12}\text{N}_2\text{O})_2(\text{SCN})_2$

(Data of Kumov, 1951)

At 15°, 100 ml H_2O dissolve 1.0 gms. Cadmium antipyrine thiocyanate.

At 15°, 100 ml $\text{C}_2\text{H}_5\text{OH}$ dissolve 0.74 gms. Cadmium antipyrine thiocyanate.

At 15°, 100 ml $(\text{C}_2\text{H}_5)_2\text{O}$ dissolve 0.076 gms. Cadmium antipyrine thiocyanate.

CO CADMIUM OXALATE CdC_2O_4 **SOLUBILITY IN WATER - SOLID PHASE $\text{CaC}_2\text{O}_4\cdot 3\text{H}_2\text{O}$**

t° Moles CdC_2O_4 per
liter sat. sol.

18 0.000165 (Kohlrausch, 1908)
.000249 (Scholder, Gadennea and Niemann, 1927)

Moles CdC_2O_4 per
1000 Cms. H_2O

25° 0.000289 (Vosburgh and Beckman, 1940)
.000309 (Pesce and Lago, 1944)
.000293 (Barney, Argersinger and Reynolds)
.000300 (Clayton and Vosburgh, 1937)
.000302 (Bardhan and Aditya, 1955)

THE SOLUBILITY OF CADMIUM OXALATE IN AQUEOUS SOLUTIONS OF
CADMIUM SULFATE, POTASSIUM OXALATE AND CADMIUM PERCHLORATE AT 25°
(Clayton, and Vosburgh, 1937; Vosburgh and Beckman, 1940)

Mixtures of Cadmium oxalate and aqueous solutions were constantly stirred for one and one-half hour in an air bath. Then dissolved cadmium oxalate was determined by titration of 200 to 400 gms. of solution with 0.01n KMnO_4 .

Results for Aq Cd Sulfate

Results for Aq K Oxalate

Mols. CdSO_4 per 1000 gms. H_2O	Mols. $\text{CdC}_2\text{O}_4 \times 10^3$ per 1000 gms. H_2O	Mols. total oxalate per 1000 gms. H_2O	Mols. $\text{CdC}_2\text{O}_4 \times 10^3$ per 1000 gms. H_2O
0.0	0.300	0.0015	0.163*
0.005	0.171	0.00576	0.194
0.010	0.188	0.009485	0.230
0.020	0.226	0.01	0.22 *
0.040	0.294	0.02456	0.374
0.080	0.410	0.02700	0.396
		0.02860	0.412
		0.04863	0.627
		0.09751	1.077

CO

Results for Ag. Cd Perchlorate
(V. and B.)

Moles per 1000 gms. H_2O	
$\text{Cd}(\text{ClO}_4)_2$	CdC_2O_4
0.005	0.000173
.010	.000191
.020	.000234
.030	.000272
.040	.000323
.050	.000353

*Barney, Argersinger and Reynolds, 1951

SOLUBILITY OF CADMIUM OXALATE IN AQUEOUS SOLUTIONS OF
POTASSIUM OXALATE AT 20° TO 30°
(Vosburgh, Newlin, Puette, Peck and Dick, 1936)

The small amounts (about 0.15%) of cadmium oxalate in the solutions are not given since they are subject to a large relative error. The results show the concentration of potassium oxalate at which double salts exist.

Cd CADMIUM

Gms. $K_2C_2O_4$ per 100 gms. sat. sol.	Solid Phase	Gms. $K_2C_2O_4$ per 100 gms. sat. sol.	Solid Phase	Gms. $K_2C_2O_4$ per 100 gms. sat. sol.	Solid Phase
2.28	$CdC_2O_4 \cdot 3H_2O$	5.89	B	24.75	C
2.25	"	6.87	"	26.25	"
2.27	" + B	7.08	" + C	26.66	"
2.35	B	8.59	C	26.79	"
3.80	"	12.29	"	28.20	" + D
4.89	"	15.73	"	28.73	" "

B = $Cd_3K_2(C_2O_4)_4 \cdot xH_2O$; C = $CdK_2(C_2O_4)_2 \cdot yH_2O$; D = $K_2C_2O_4 \cdot H_2O$.
The solubility of both of the double salts is small.

CO

Data on the solubility of CdC_2O_4 in $Cd(NO_3)_2$ and $(NH_4)_2C_2O_4$ solutions are given by Babkin, Nozhenka and Shevchenko, 1955.

SOLUBILITY OF CADMIUM OXALATE IN SOLUTIONS OF SALTS WITHOUT A COMMON ION AT 25°

(Pesca and Lago, 1944; Vosburgh and Beckman, 1940; Cavigli, 1949;
Bardhan and Aditya, 1955; see also Accascina and Schiavo, 1953
for data in K_2SO_4 , KNO_3 , KCl , $NaCl$ and $NaNO_3$ solutions.)

In Na_2SO_4 aq. (P. and L.)		In $MgSO_4$ aq. (P. and L.)		In K_2SO_4 aq. (V. and B.)		In $KClO_3$ aq. (V. and B.)	
Moles per 1000 gms. H_2O		Moles per 1000 gms. H_2O		Moles per 1000 gms. H_2O		Moles per 1000 gms. H_2O	
Na_2SO_4	CdC_2O_4	$MgSO_4$	CdC_2O_4	K_2SO_4	CdC_2O_4	$KClO_3$	CdC_2O_4
0.0	0.000309	0.226	0.00659	0.005	0.000390	0.0	0.000289
0.078	0.000947	.472	.01375	.010	.000463	0.005	.000316
.156	.001294	.681	.02571	.020	.000564	.010	.000341
.237	.001623	.901	.03892	.040	.000719	.020	.000365
.313	.001915	1.132	.05229			.040	.000413
.393	.002182	1.583	.07089			.080	.000475
.469	.002349	2.321	.10568				
.688	.002761						

In KNO_3 aq.* at 25° (C.) Moles per liter		at 35° (B. and A.) Moles per liter		In $NaC_2H_3O_2$ aq. at 35° (B. and A.) Moles per liter	
KNO_3	CdC_2O_4	KNO_3	CdC_2O_4	$NaC_2H_3O_2$	CdC_2O_4
0.1976	0.000989	0.01	0.000427	0.01	0.000537
0.3956	.00233	.02	.000468	.02	.000615
0.7912	.00796	.04	.000531	.04	.000877
1.5824	.0442	.05	.000540	.05	.000915
2.0000	.105	.06	.000563	.06	.001003
		.08	.000612	.08	.001149
		.10	.000653	.10	.001351
		.12	.000685	.12	.001404
		.15	.000728	.15	.001685

*For further data see Babkin, Nozhenko, and Shevchenko, 1955.

CADMIUM CHLORIDE CdCl_2

Cl

SOLUBILITY IN WATER

(Dietz, 1900; hering, 1936; above 100° Benrath, Gjedebø, Schiffers and Wunderlich, 1937; Benrath, 1941)

Gms. CdCl ₂				Gms. CdCl ₂					
d. of		per 100		d. of		per 100			
sat.		gms.		sat.		gms.			
t°	sol.	sat.	sol.	Solid Phase	t°	sol.	sat.	sol.	Solid Phase
-10.2	-	43.0		lee + CdCl ₂ ·4H ₂ O	10	-	57.47		CdCl ₂ ·H ₂ O
-9	-	43.58		CdCl ₂ ·4H ₂ O	20	-	57.35		"
-7.2	-	44.7		"	37.5	1.836	57.4		"
-5.6	-	45.75		" + CdCl ₂ ·2½H ₂ O	45	1.830	57.5		"
0.0	-	49.39		CdCl ₂ ·4H ₂ O	60	1.820	57.7		"
+10.0	-	55.12		"	80	1.816	58.35		"
15	-	59.12		"	100	1.821	59.55		"
-10	-	44.35		CaCl ₂ ·2½H ₂ O	124	-	61.0		"
-33	-	46.3		"	141	-	62.5		"
0	1.635	47.3		"	166	-	66.0		"
12.5	1.699	50.75		"	174	-	69.0		" + CdCl ₂
18.0	1.741	52.52		"	196	-	70.5		CdCl ₂
25	1.778	54.65		"	227	--	76.6		"
30	-	56.91		"	261	-	80.0		"
32.5	1.829	56.95		"	330	-	84.5		"
33.8	1.837	57.4		" + CaCl ₂ ·H ₂ O	383	-	87.5		"
					433	-	91.4		"
					481	-	94.6		"
					564	m. pt.	100.0		"

EQUILIBRIUM IN THE SYSTEM $\text{CdCl}_2 - \text{HCl} - \text{H}_2\text{O}$ AT 25°
(Kuznetsov and Koahukhovski, 1936a)

Gms. per 1000		Gas. per 1000		Gas. per 1000		Solid Phase	
gms. H_2O		gms. H_2O		gms. H_2O		gms. H_2O	
CdCl_2	HCl	Solid Phase	CdCl_2	HCl	Solid Phase	CdCl_2	HCl
1194	0.0	$\text{CdCl}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	1292	280.7	$2\text{CdCl}_2 \cdot \text{H}_2\text{O} + 2\text{CdCl}_2 \cdot \text{HCl} \cdot 4\text{H}_2\text{O}$		
1094	59.90	"	1217	328.0	$2\text{CdCl}_2 \cdot \text{HCl} \cdot 4\text{H}_2\text{O}$		
1065	97.29	"	1169	363.7	"		
1086	127.9	$\text{CdCl}_2 \cdot \text{H}_2\text{O}$	1149	388.1	"		
1080	125.0	"	1135	425.9	"		
1061	150.6	"	1055	491.3	"		
1099	202.0	"	938.6	531.5	$\text{CdCl}_2 \cdot \text{HCl} \cdot 3\text{H}_2\text{O}$		
1118	225.8	"	838.8	568.1	"		
1184	244.9	"	785.2	640.7	"		

Cd CADMIUM

THE SYSTEM CADMIUM CHLORIDE - COBALT CHLORIDE - WATER AT 25°
(Bassett, Henshall, Sergeant and Shipley, 1939)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CoCl ₂	CdCl ₂	Solid Phase	CoCl ₂	CdCl ₂	Solid Phase
0.0	54.62	Cd2½	24.00	33.24*	4.1.10
7.38	48.73	"	28.63	29.82*	"
11.71	45.40	"	15.80	41.57	" + 2.1.12
0.0	58.10*	Cd1	19.26	35.95	2.1.12
4.71	51.78*	"	22.33	32.10	"
6.77	49.66*	"	24.33	30.02	"
9.30	47.36*	"	25.00	29.61	"
12.23	45.20	" + Cd2½	31.96	29.21*	1.2.12
13.74	44.25	" + 4.1.10	37.11	24.15*	"
14.01	43.95	4.1.10	27.75	28.22	2.1.12 + Co6
15.02	42.57	"	28.66	23.71	Co6
15.16	42.43	"	31.00	17.99	"
16.01	41.30*	"	32.45	11.20	"
19.72	37.07*	"	34.06	5.39	"
21.62	35.10*	"	35.87	0.0	"
22.43	34.51*	"			

*Metastable

Cd2½ = CdCl₂·2½H₂O; Cd1 = CdCl₂·H₂O; 4.1.10 = 4CdCl₂·CoCl₂·10H₂O;
2.1.12 = 2CdCl₂·CoCl₂·12H₂O; 1.2.12 = CdCl₂·2CoCl₂·12H₂O; Co6 = CoCl₂·6H₂O.

Additional data of Benrath, 1927:

Mols. CdCl ₂ per 1.0 Mols. CdCl ₂ + CoCl ₂	Mols. H ₂ O to dissolve 1.0 Mol. CdCl ₂ + CoCl ₂
0.000	12.66
0.0514	11.92
0.1166	10.90
0.2185	9.37
0.3261	7.64
0.402	6.38
0.411	6.25
0.437	6.44
0.578	6.86
0.654	6.52
0.704	6.37
0.803	6.93
1.000	7.94

THE SYSTEM CADMIUM CHLORIDE-POTASSIUM CHLORIDE-WATER
(Results of Sudhaus, 1914)

Gms. per 100 gms. H ₂ O			Gms. per 100 gms. H ₂ O		
CdCl ₂	KCl	Solid Phase	CdCl ₂	KCl	Solid Phase
Results at 19.3°			Results at 40.1°		
111.3	0.0	CdCl ₂ ·2½H ₂ O	133.85	0.0	CdCl ₂ ·H ₂ O
59.59	6.7	" + D _{1.1.1}	92.15	2.70	" + D _{1.1.1}
*26.98	11.09	D _{1.1.1}	51.90	11.50	D _{1.1.1}
11.61	30.04	" + D _{1.4}	*37.91	15.21	"
1.44	34.76	D _{1.4} + KCl	24.45	21.73	"
0.0	33.94	KCl	18.97	35.51	"
Results at 29.7°			19.92	37.63	" + D _{1.4}
129.65	0.0	CdCl ₂ ·2½H ₂ O	2.98	40.45	D _{1.4} + KCl
97.62	0.70	"	0.0	40.36	KCl
68.23	7.08	" + D _{1.1.1}	Results at 54.5°		
47.12	9.89	D _{1.1.1}	133.9	0.0	CdCl ₂ ·H ₂ O
*32.67	13.06	"	102.15	2.32	" + D _{1.1.1}
24.26	16.10	"	*44.01	18.39	D _{1.1.1}
15.99	25.97	"	26.13	43.78	" + D _{1.4}
15.47	33.58	" + D _{1.4}	4.20	45.52	D _{1.4} + KCl
2.42	37.66	D _{1.4} + KCl	0.0	43.00	KCl
0.0	37.21	KCl			

D_{1.1.1} = CdCl₂·KCl·H₂O, D_{1.4} = CdCl₂·4KCl.

*Shows the solubility of the double salt in water.

SOLUBILITY OF THE DOUBLE SALT CdCl₂·4KCl IN WATER
(Sudhaus, 1914)
(See also pp. 715, 716)

t*	Gms. CdCl ₂ ·4KCl per 100 gms. H ₂ O	Mol. Ratio in Solution
19.3	41.65	1CdCl ₂ : 6.37 KCl
23.6	45.35	" : 5.85 "
29.7	49.05	" : 5.34 "
40.1	57.55	" : 4.60 "
50.2	68.89	" : 4.30 "
54.5	69.91	" : 4.12 "

(Cont.)

Cd CADMIUM

(Results of Hering, 1936)

The author completed and corrected the results of Sudhaus (1914) p. 713, by determining numerous isotherms. By plotting these results he obtained the limiting values of temperature and concentration for the several double compounds formed.

	t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
			CdCl ₂	KCl				CdCl ₂	KCl	
Cl	-7.8	-	41.6	0.35	3.1.4	25	1.457	35.3	4.96	1.1.1
	-6.2	-	0.9	19.15	1.4	"	1.240	9.67	20.6	1.1
	-5.7	-	4.4	15.15	1.1.1	50	1.579	42.8	5.6	1.1
	-3.7	-	28.5	3.05	"	"	1.312	13.0	26.1	1.4
	0	1.603	45.5	0.2	3.1.4	"	1.151	3.3	29.55	"
	"	1.433	35.25	1.57	"	100	-	58.8	3.55	3.1.4
	"	1.352	28.65	3.45	1.1.1	"	1.881	58.6	5.0	"
	"	1.337	27.25	3.75	"	"	1.878	58.3	5.5	"
	"	1.268	21.8	4.5	"	"	-	51.45	7.8	1.1
	"	1.167	7.85	10.05	"	"	-	39.4	12.75	"
	"	1.169	5.15	16.5	"	"	-	27.5	21.7	"
	"	1.172	4.75	17.6	1.4	"	-	25.25	29.8	"
	"	1.154	1.9	19.3	"	"	-	23.7	30.7	1.4
	25	1.722	52.1	0.29	3.1.4	"	1.415	19.55	31.6	"
	"	1.571	44.05	1.33	"	"	-	10.15	34.45	KCl
	"	1.496	38.5	3.65	"	"	1.275	6.4	35.25	"

Compositions of the INVARIANT SOLUTIONS:

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdCl ₂	KCl	
-10.3	-	43.2	0.26	Cd ₄ + 3.1.4 + Ice
-7.2	-	44.9	0.20	" "
-3.3	-	47.0	0.24	" "
-5.7	-	45.8	0.18	" + Cd ₂ + 3.1.4
0	1.639	47.4	0.19	Cd ₂ + 3.1.4
25	1.783	54.7	0.19	" "
32	1.830	56.9	0.16	" "
33.7	1.843	57.4	0.15	" " + Cd ₄
35	1.841	57.5	0.18	Cd ₄ + 3.1.4
50	1.834	57.6	0.43	" "
75	1.844	58.3	1.45	" "
90	1.869	59.2	2.75	" "
100	1.901	59.9	4.1	" "
-5.8	-	30.05	2.75	3.1.4 + 1.1.1 + Ice
0	1.391	31.5	3.1	" "
11	1.434	34.15	3.7	" "
25	1.488	37.45	4.45	" "
28.8	1.503	38.3	4.8	3.1.4 + 1.1.1 + 1.1
32	1.516	39.05	4.9	3.1.4 + 1.1
50	1.593	43.6	5.45	" "
75	1.715	50.3	5.85	" "

(Cont.)

Compositions of the INVARIANT SOLUTIONS:--Contd.

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdCl ₂	KCl	
100	1.874	57.8	5.9	3.1.4 + 1.1
- 8.1	-	4.0	15.7	Ice + 1.1.1 + 1.4
0	1.176	5.05	17.5	1.1.1 + 1.4
11	1.206	6.8	19.6	" "
12.4	1.212	7.0	20.0	1.1.1 + 1.4 + 1.1
14	1.215	7.3	20.25	1.1 + 1.4
25	1.250	9.35	22.1	" "
31	1.268	10.45	23.1	" "
50	1.328	14.35	25.8	" "
65	1.377	17.5	27.6	" "
75	1.410	19.8	28.6	" "
85	1.443	22.0	29.45	" "
100	1.491	25.2	30.2	" "
-10.7	-	0.45	19.65	Ice + 1.4 + KCl
0	1.161	0.6	21.95	1.4 + KCl
25	1.193	1.3	26.5	" "
50	1.223	2.7	30.15	" "
75	1.259	5.1	32.95	" "
100	1.303	8.6	35.35	" "

Cd₄ = CdCl₂·4H₂O; Cd₂ = CdCl₂·2½H₂O; 3.1.4 = 3CdCl₂·KCl·4H₂O
 1.4 = CdCl₂·4KCl; 1.1.1 = CdCl₂·KCl·H₂O; 1.1 = CdCl₂·KCl.

CADMIUM POTASSIUM CHLORIDES

Cl

SOLUBILITY OF CADMIUM POTASSIUM DOUBLE CHLORIDES IN WATER
(Hering, 1936)

(See also pp. 713, 716)

t°	Gms. anhy. d. of double salt sat. per 100 gms. sol. sat. sol.		Solid Phase	t°	Gms. anhy. d. of double salt sat. per 100 gms. sol. sat. sol.		Solid Phase
	sol.	sat. sol.			sol.	sat. sol.	
-4.1	-	19.6	Ice + 1.1.1	45	1.349	36.2	1.1
0	1.196	21.0	1.1.1	60	1.391	40.3	"
12.5	1.238	25.2	"	80	1.444	45.45	"
25	1.283	29.7	"	100	1.494	50.3	"
32.5	1.309	32.3	"	60.5	-	43.7	1.4
33.5	1.313	32.65	"	75	-	46.4	"
36.6	1.324	33.5	" + 1.1	85	-	48.3	"
37.5	1.328	34.05	1.1	100	-	51.1	"

1.1 = CdCl₂·KCl; 1.1.1 = CdCl₂·KCl·H₂O; 1.4 = CdCl₂·4KCl.

Cd CADMIUM

(Results of Rimbach (1897) for $\text{CdCl}_2 \cdot 4\text{KCl}$.)

The double salt is decomposed when dissolved in water at ordinary temperature.

t°	100 Grams Solution contain Gas.		
	Cd	Cl	K
4	3.64	9.84	8.31
23.6	5.66	14.02	11.52
50.2	9.10	18.09	13.60
108.9	11.94	23.11	17.16

Cl

Decomposition of the tetrachloride $\text{CdCl}_2 \cdot 4\text{KCl}$ in chloride solutions: Rimbach (1897) determined the ratio $\text{CdCl}_2:\text{KCl}$ in solution when increasing amounts of (other) chloride were added to the solution. From this he found the minimum concentration of (added) chloride needed to make $\text{CdCl}_2 \cdot 4\text{KCl}$ congruently soluble. The compositions of these "transition" points (between congruent and incongruent solubility) are given below:

Added Chloride	Mols. per 100 Mols. H_2O		Added Chloride	Density of Solutions
	CdCl_2	KCl		
HCl	0.074	0.296	19.80	1.1403
LiCl	0.344	1.376	9.30	1.1280
CsCl_2	0.544	2.176	3.80	1.2333
KCl	1.034	6.514*	2.378	1.214

*Total

THE SYSTEM CADMIUM CHLORIDE - AMMONIUM CHLORIDE - WATER AT 35°
(Lushmaya, 1950)

Read from the diagram drawn by the author.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdCl_2	NH_4Cl		CdCl_2	NH_4Cl	
58.0	0.0	$\text{CdCl}_2 \cdot \text{H}_2\text{O}$	9.0	28.0	$\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$
49.0	1.5	" + $\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$	5.0	30.0	" + NH_4Cl
34.5	3.8	$\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$	3.5	30.0	NH_4Cl *
24.5	9.7	"	0.0	30.5	"
13.7	26.5	" + $\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$			

*May be a limited solid solution of CdCl_2 in NH_4Cl .

CADMIUM AMMONIUM CHLORIDE $\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$.

Cl

SOLUBILITY IN WATER
(Rimbach, 1897)

t°	100 Gms. Solution contain Gms.			Gms. $\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$ per 100 Gms.	
	Cd	Cl	NH	Solution	Water
2.4	14.26	13.44	2.24	29.94	42.74
16.0	15.82	15.07	2.56	33.45	50.26
41.2	18.61	17.46	2.89	38.96	63.83
63.8	20.92	19.73	3.34	43.99	78.54
105.9	24.70	23.52	4.01	52.23	109.33

CADMIUM (Tetra) AMMONIUM CHLORIDE $\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$.

Cl

IN CONTACT WITH WATER
(Rimbach, 1897)

The salt is decomposed in aqueous solution.

t°	100 Gms. Solution contain Gms.			Atomic Relation in Solution		
	Cd	Cl	NH ₄	Cd	:	Cl : NH ₄
3.9	5.75	18.17	7.37	1	9.96	7.96
16.1	6.96	20.26	7.97	1	9.20	7.13
40.2	9.91	23.84	8.92	1	7.61	5.61
58.5	12.50	26.53	9.35	1	6.71	4.66
112.9	16.66	31.79	10.78	1	6.02	4.02
113.9	16.51	32.71	11.30	1	6.26	4.26

SOLUBILITY OF MIXTURES OF CADMIUM TETRA AMMONIUM CHLORIDE
AND CADMIUM AMMONIUM CHLORIDE IN WATER
(Rimbach, 1902)

t°	100 Gms. Solution contains Gms.			Atomic Relation			Solid Phase, Mol. per cent of:	
	Cd	Cl	NH ₄	Cd	:	Cl : NH ₄	$\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$	$\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$
1.1	5.34	17.62	7.27	1	10.47	8.50	49.6	50.4
14.0	7.12	19.86	7.84	1	8.84	6.87	47.0	53.0
40.7	10.24	23.82	8.85	1	7.37	5.37	77.0	23.0
58.5	12.50	26.53	9.35	1	6.71	4.66	...	...

SOLUBILITY OF MIXTURES OF CADMIUM TETRA AMMONIUM CHLORIDE
AND AMMONIUM CHLORIDE IN WATER
(Rimbach, 1902)

t°	100 Gms. Solution contains Gms.			Atomic Relation			Solid Phase, Mol. per cent of:	
	Cd	Cl	NH	Cd	: Cl	: NH ₄	NH ₄ Cl	CdCl ₂ · 4NH ₄ Cl
1.0	2.82	17.11	7.82	1	19.21	17.28	59.0	41.0
13.2	2.76	18.84	8.71	1	21.62	19.62	74.0	26.0
40.1	3.16	22.56	10.49	1	22.65	20.74	71.0	29.0
58.2	3.51	25.21	11.72	1	22.79	20.89	69.0	31.0

EQUILIBRIUM IN THE SYSTEM CdCl₂ - NaCl - H₂O
(Hering, 1945, 1946)

The author studied the entire system from the freezing points to 100°, and presents diagrams which show the solid phases in equilibrium with saturated solutions of any composition and temperature. There are five double salts in the system:

CdCl₂·NaCl·2H₂O (above 37.7°) (Always congruently soluble)
CdCl₂·NaCl·3H₂O (All temperatures) (Congruently soluble above 10.5°)
4CdCl₂·8NaCl·14H₂O (Below 44.0°) (Always congruently soluble)
CdCl₂·8NaCl·16H₂O (Below 19.2°) (Always incongruently soluble)
"Y" (Composition undetermined) (Below about 3.8°)

The results agree very well with those of Basset, Henshall, and Sergeant at 25° (p. 720), but disagree with the older data of Sudhaus (1914) who found only one double salt from 19° to 55°.

The author also includes a summary of the double salts of Cadmium and Mercury halides in binary and ternary systems with alkali metals.

Gms. per 100 gms. sat. sol.

CdCl ₂		NaCl	Density	Solid Phase
Results at 0°				
46.45	2.5	-	-	CdCl ₂ ·2½H ₂ O + 4:3:14
42.3	3.6	1.587	-	4:3:14
38.7	4.4	1.533	-	"
29.0	7.75	1.409	-	"
25.4	8.65	1.357	-	"
19.7	13.0	-	-	"
17.8	15.2	-	-	4:3:14 + 1:2:3
6.8	20.5	1.236	-	1:2:3
5.55	21.35	-	-	"
(M) 3.15	24.0	-	-	"
(M) 4.95	21.95	-	-	1:2:3 + 1:8:16

(M) Indicates Metastable

Gma. per 100 gms. sat. sol.

	CdCl ₂	NaCl	Density	Solid Phase
	Results at 0°--Contd.			
	*5.05	21.9	-	"Y", + 1:8:16
	4.45	22.1	-	"
	3.15	22.55	-	1:8:16
	1.1	23.65	-	"
	0.75	24.0	-	"
(M)	2.1	25.9	-	1:2:3 + NaCl
	0.07	26.35	-	1:8:16 + NaCl + NaCl·2H ₂ O

Cl

Results at 19.3°

51.6	3.6	1.770	CdCl ₂ ·2½H ₂ O + 4:3:13
50.2	4.1	1.745	4:3:13
41.0	7.3	1.600	"
36.3	9.3	1.537	"
28.4	14.5	1.464	4:3:13 + 1:2:3
4.3	25.8	1.243	1:2:3 + NaCl

Results at 39°

54.2	6.2	1.860	CdCl ₂ ·H ₂ O + 4:3:13
50.4	7.8	1.792	4:3:13
46.5	9.6	1.729	"
42.6	11.7	1.678	"
39.7	13.3	1.639	1:1:2 + 1:2:3
37.5	13.8	1.600	1:2:3
8.5	25.45	1.278	1:2:3 + NaCl

Results at 60°

9.0	53.4	1.866	CdCl ₂ ·H ₂ O + 1:1:2
10.6	49.9	1.803	1:1:2
11.6	47.4	1.764	"
14.0	42.6	1.686	"
14.7	41.1	1.662	1:1:2 + 1:2:3
16.3	36.5	1.588	1:2:3
24.8	15.1	1.338	1:2:3 + NaCl

Results at 100°

57.8	2.6	-	CdCl ₂ ·H ₂ O
56.0	5.9	-	"
54.9	11.2	-	"
54.7	12.6	-	CdCl ₂ ·H ₂ O + 1:1:2

(M) Indicates Metastable.

*The exact composition of the double salt "Y" was not determined, but the ratio of NaCl:CdCl₂ in it was greater than 6:5:1. The equilibrium temperature for the reaction $Y \rightleftharpoons 1:2:3 + 1:8:16$ + Solution was not determined exactly and is thought to be 3.8°, but may be as low as -0.6°. At temperatures below 0°, the compound has a well defined region of stability.

(Cont.)

Cd CADMIUM

Gms. per 100 gms. sat. sol.

CdCl ₂ NaCl		Density	Solid Phase
Results at 100°--Contd.			
53.6	13.0	-	1:1:2
48.6	15.6	-	"
47.6	16.4	-	1:1:2 + 1:2:3
39.1	19.7	-	1:2:3
28.9	24.0	-	1:2:3 + NaCl
27.0	24.3	-	NaCl
18.0	26.3	-	"

C1

INVARIANT SOLUTIONS IN THE SYSTEM CdCl₂ - NaCl - H₂O
(Hering)

t°	Gms. CdCl ₂ per 100 gms. sat. sol.	Gms. NaCl per 100 gms. sat. sol.	Solid Phase
44.0	53.8	7.4	CdCl ₂ ·H ₂ O + 1:1:2 + 4:3:14
29.8	54.7	4.4	CdCl ₂ ·H ₂ O + CdCl ₂ ·2½H ₂ O + 4:3:14
-7.1	44.55	2.2	CdCl ₂ ·2½H ₂ O + CdCl ₂ ·4H ₂ O + 4:3:14
-11.4	41.85	2.25	CdCl ₂ ·4H ₂ O + 4:3:14 + Ice
37.7	39.6	13.2	4:3:14 + 1:1:2 + 1:2:3
-12.2	11.45	15.6	4:3:14 + 1:2:3 + Ice
-16.7	4.85	19.1	1:2:3 + 1:8:16 + Ice
-17.0	2.0	19.85	"Y" + 1:8:16 + Ice
-21.1	0.03	23.2	NaCl·2H ₂ O + 1:8:16 + Ice

RESULTS OF BASSETT, HENSHALL AND SERGEANT, 1939 FOR THE SYSTEM
CdCl₂ + NaCl + H₂O AT 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NaCl	CdCl ₂		NaCl	CdCl ₂	
0.0	58.10*	CdCl ₂ ·H ₂ O	12.62	33.32*	1.2.3
2.18	55.93*	"	13.78	31.76	" + 4.3.14
0.0	54.62	CdCl ₂ ·2½H ₂ O	14.46	30.55	"
2.61	53.55	"	15.37	27.34	"
3.44	55.52*	CdCl ₂ ·H ₂ O + 4.3.14	16.97	22.26	"
3.95	53.71	CdCl ₂ ·2½H ₂ O + "	18.36	17.37	"
4.68	50.93	4.3.14	19.95	14.42	"
6.72	45.09	"	23.14	8.62	"
8.65	40.75	"	25.50	5.25	" + NaCl
12.82	33.32	"	25.90	0.0	NaCl ••

* = metastable

4.3.14 = 4CdCl₂·3NaCl·14H₂O; 1.2.3 = CdCl₂·2NaCl·3H₂O.

(Cont.)

It is stated that the conclusions of Sudhaus, 1914, in regard to this system are erroneous due to inadequacy of the analytical data.

In addition to the above results the authors have also studied the formation of solid solutions in the systems $\text{CdCl}_2 + \text{NaCl} + \text{NiCl}_2 + \text{H}_2\text{O}$ and $\text{CdCl}_2 + \text{NaCl} + \text{CoCl}_2 + \text{H}_2\text{O}$.

Additional determinations upon this system at temperatures between 19° and 60° are given by Adolff and Hering, 1934, in the form of a diagram showing the areas in which the several double salts exist. Numerical results are not given. Two new double salts of the composition $5\text{CdCl}_2 \cdot 4\text{NaCl} \cdot 17\text{H}_2\text{O}$ and $\text{CdCl}_2 \cdot \text{NaCl} \cdot \text{H}_2\text{O}$ were identified.

CADMIUM SODIUM CHLORIDES

Cl

SOLUBILITY OF EACH IN WATER
(Hering, 1945, 1946)

$\text{CdCl}_2 \cdot \text{NaCl}$		$4\text{CdCl}_2 \cdot 3\text{NaCl} \cdot 14\text{H}_2\text{O}$		$\text{CdCl}_2 \cdot 2\text{NaCl}$	
Gms. $\text{CdCl}_2 \cdot \text{NaCl}$ per 100 gms. sat. sol.		Gms. $4\text{CdCl}_2 \cdot 3\text{NaCl}$ per 100 gms. sat. sol.		Gms. $\text{CdCl}_2 \cdot 2\text{NaCl}$ per 100 gms. sat. sol.	
t°		t°		t°	
38.3	53.2	19.3	46.0	13.0	38.8
60.0	56.7	39.0	55.1	19.3	40.1
100.0	64.3	40.3	55.5	24.0	41.2
				40.0	44.2
				50.0	46.1
				60.0	47.9
				70.0	49.8
				80.0	51.7
				90.0	53.7
				100.0	55.9

THE SYSTEM CADMIUM CHLORIDE - LITHIUM CHLORIDE - WATER
(Bliden, 1954)

Note that the values for the solubility of CdCl_2 in water alone are high.

Results at 25°

G.s. per 100 gms. sat. sol.

LiCl	CdCl_2	Solid Phase
45.95	0.0	$\text{LiCl} \cdot \text{H}_2\text{O}$
44.20	2.02	"
42.31	6.48	"
41.43	9.63	"
39.61	13.00	" + $\text{LiCl} \cdot \text{CdCl}_2 \cdot 2.5\text{H}_2\text{O}$
37.60	15.14	$\text{LiCl} \cdot \text{CdCl}_2 \cdot 2.5\text{H}_2\text{O}$
32.68	18.96	"

(Cont.)

Cd CADMIUM

Results at 25°--Contd.

Gms. per 100 gms. sat. sol.

<div> <div>LiCl</div> <div>CdCl₂</div> </div>		Solid Phase
28.12	24.04	LiCl·CdCl ₂ ·2.5H ₂ O
25.07	27.80	"
19.96	34.25	"
17.40	37.68	"
14.28	42.55	"
12.63	46.07	"
10.54	49.12	" + CdCl ₂ ·2.5H ₂ O
7.20	52.51	CdCl ₂ ·2.5H ₂ O
3.12	55.82	"
0.0	59.48	"

Results at 40°

47.98	0.0	LiCl·H ₂ O
45.35	4.26	"
39.74	15.30	"
38.86	18.12	" + LiCl·CdCl ₂ ·2.5H ₂ O
37.50	19.51	LiCl·CdCl ₂ ·2.5H ₂ O
28.13	28.39	"
17.38	39.167	"
15.57	42.20	" + CdCl ₂ ·H ₂ O
13.08	45.15	CdCl ₂ ·H ₂ O
4.28	55.47	"
0.0	62.14	"

Cl CADMIUM (Mono)RUBIDIUM CHLORIDE CdCl₂·RbCl.

SOLUBILITY OF CADMIUM MONORUBIDIUM CHLORIDE IN WATER
(Rimbach, 1902)

t°	100 Gms. Solution contain Gms.			Gms. CdCl ₂ ·RbCl per 100 Gms.	
	Cd	Cl	Rb	Solution	Water
1.2	4.80	4.53	3.63	12.97	14.90
14.5	6.20	5.88	4.75	16.80	20.19
41.4	9.34	8.86	7.14	25.31	33.89
57.6	11.40	10.78	8.63	30.83	44.58
103.9	17.14	16.37	13.39	46.62	87.36

CADMIUM (Tetra)RUBIDIUM CHLORIDE $\text{CdCl}_2 \cdot 4\text{RbCl}$.

IN CONTACT WITH WATER
(Rimbach, 1902)

The double salt decomposes to $\text{CdCl}_2 \cdot \text{RbCl}$ and RbCl .

t°	100 Gms. Solution contain Gms.			Atomic Relation			Solid Phase Mol. per cent of:	
	Cd	Cl	Rb	Cd	Cl	Rb	$\text{CdCl}_2 \cdot \text{RbCl}$	$\text{CdCl}_2 \cdot 4\text{RbCl}$
0.7	0.65	6.52	14.73	1	31.88	29.88	30	70
8.8	1.07	7.37	16.13	1	21.89	19.89	24	76
13.8	1.32	7.86	16.93	1	18.88	16.83	16	84
42.4	3.21	11.35	22.45	1	11.21	9.21	14	86
59.0	4.61	13.41	25.31	1	9.23	7.23	33	67
108.4	8.94	18.57	31.15	1	6.57	4.59	..	..

SOLUBILITY OF MIXTURES OF $\text{CdCl}_2 \cdot 4\text{RbCl}$ and RbCl IN WATER
(Rimbach, 1902)

t°	100 Gms. Solution contain Gms.			Atomic Relation			Solid Phase Mol. per cent of:	
	Cd	Cl	Rb	Cd	Cl	Rb	$\text{CdCl}_2 \cdot 4\text{RbCl}$	RbCl
0.4	..	12.86	30.97	..	1	1	55	45
14.8	..	13.62	32.81	..	1	1	67	33
17.9	..	14.0	33.71	..	1	1	80	20

THE SYSTEM CADMIUM CHLORIDE - CALCIUM CHLORIDE - WATER AT 25°
(Bassett and Strain, 1952)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CdCl_2	CaCl_2	Solid Phase	CdCl_2	CaCl_2	Solid Phase
0.0	45.05	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	38.3	19.3	S.S.
1.6	44.6	" + $\text{CdCl}_2 \cdot 2\text{CaCl}_2 \cdot 12\text{H}_2\text{O}$	43.1	16.7	S.S.
4.5	39.8	$\text{CdCl}_2 \cdot 2\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	46.8	14.9	S.S.
8.7	37.5	"	47.8	11.3	S.S. + $\text{CdCl}_2 \cdot \text{H}_2\text{O}$
12.0	35.0	"	48.6	8.3	$\text{CdCl}_2 \cdot \text{H}_2\text{O}$
16.5	32.5	"	50.0	6.1	"
17.8	32.2	"	54.62	0.0	"
21.8	30.5	"	48.6	10.0*	$\text{CdCl}_2 \cdot 2.5\text{H}_2\text{O}$
24.8	29.1*	"	48.9	8.9*	"
24.3	28.8	" + S.S.	51.8	5.6*	"
25.0	28.3	S.S.	58.10	0.0*	"
32.8	21.7	S.S.			

*metastable S.S. = Solid solution of $[\text{CdCl}_2 \cdot \text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}]$

Some results for the system $\text{CdCl}_2 + \text{CaCl}_2 + \text{NaCl} + \text{H}_2\text{O}$ at 25° are also given (Bassett and Strain, 1952).

Cd CADMIUM

THE SYSTEM CADMIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER AT 25° (Bassett and Strain, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdCl ₂	MgCl ₂		CdCl ₂	MgCl ₂	
0.0	36.2	MgCl ₂ ·6H ₂ O	27.1	21.8*	S.S.·4H ₂ O
0.4	35.7	" + CdCl ₂ ·2MgCl ₂ ·12H ₂ O	31.4	21.0*	"
0.4	35.3	CdCl ₂ ·2MgCl ₂ ·12H ₂ O	26.6	19.2	2CdCl ₂ ·MgCl ₂ ·12H ₂ O
2.3	31.6	"	33.4	14.2	"
5.4	30.0	"	37.7	12.6	"
14.7	26.2	"	40.7	11.5	"
24.9	22.4	" + 2CdCl ₂ ·MgCl ₂ ·12H ₂ O	47.0	8.9	"
27.2	21.9*	CdCl ₂ ·2MgCl ₂ ·12H ₂ O	48.1	8.6	" + CdCl ₂ ·2.5H ₂ O
7.0	29.6*	Tetrahydrated Solid Solution	50.6	3.2	CdCl ₂ ·2.5H ₂ O
14.5	26.1*	"	54.62	0.0	"
15.1	26.1*	"	48.5	8.8*	2CdCl ₂ ·MgCl ₂ ·12H ₂ O + CdCl ₂ ·H ₂ O
20.0	24.2*	"	49.2	7.2*	CdCl ₂ ·H ₂ O
20.4	24.1*	"	52.8	3.5*	"
24.8	22.3*	"	58.10	0.0*	"
26.0	22.3*	"			

*Metastable

Cl CADMIUM MAGNESIUM CHLORIDE 2CdCl₂·MgCl₂·12H₂O

SOLUBILITY IN WATER (Rimbach, 1902)

t°	100 Gms. Solution contain Gms.			Gms. 2(CdCl ₂)·MgCl ₂ per 100 Gms.	
	Cd	Cl	Mg	Solution	Water
2.4	22.14	21.06	2.41	45.61	83.86
20.8	24.30	22.80	2.55	49.69	98.77
45.5	26.24	24.55	2.72	53.51	115.10
67.2	28.45	26.71	2.98	58.14	138.90
121.8	31.84	30.20	3.44	65.48	189.69

THE SYSTEM CADMIUM CHLORIDE - MANGANOUS CHLORIDE - WATER AT 25° (Bassett and Strain, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdCl ₂	MnCl ₂		CdCl ₂	MnCl ₂	
0.0	43.55	MnCl ₂ ·4H ₂ O	45.5	11.3	CdCl ₂ ·2.5H ₂ O
7.7	40.4	"	51.6	2.9	"
16.5	36.6	"	54.62	0.0	"
27.5	31.1	"	43.0	15.3*	4CdCl ₂ ·MnCl ₂ ·10H ₂ O + CdCl ₂ ·H ₂ O
31.6	27.5	" + 4CdCl ₂ ·MnCl ₂ ·10H ₂ O	43.7	14.8*	CdCl ₂ ·H ₂ O
36.5	22.2	4CdCl ₂ ·MnCl ₂ ·10H ₂ O	44.3	13.0*	"
37.1	21.9	"	47.3	8.6*	"
40.9	18.0	" + CdCl ₂ ·2.5H ₂ O	58.10	0.0*	"

*Metastable

Some results for the system CdCl₂ + MnCl₂ + NaCl + H₂O at 25° are also given.

THE SYSTEM CADMIUM CHLORIDE - CUPRIC CHLORIDE - WATER AT 25°
(Bassett and Strain, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdCl ₂	CuCl ₂		CdCl ₂	CuCl ₂	
0.0	43.6	CuCl ₂ ·2H ₂ O	31.8	25.1	CdCl ₂ ·CuCl ₂ ·4H ₂ O
8.2	39.4	"	36.4	22.6	"
13.7	36.8	"	38.8	21.1	" + CdCl ₂ ·H ₂ O
21.4	32.4	"	39.7	18.8	CdCl ₂ ·2.5H ₂ O + "
22.4	32.0	" + CdCl ₂ ·CuCl ₂ ·4H ₂ O	47.4	7.1	CdCl ₂ ·2.5H ₂ O
23.7	31.4	CdCl ₂ ·CuCl ₂ ·4H ₂ O	54.62	0.0	"
24.4	30.7	"	38.6	20.6*	CdCl ₂ ·H ₂ O
28.1	27.6	"	46.5	11.0*	"
30.5	26.2	"	53.5	4.3*	"
30.7	26.4	"	58.10	0.0*	"

*Metastable

THE SYSTEM CADMIUM CHLORIDE - NICKEL CHLORIDE - WATER AT 25°
(Bassett, Henshall, Sergeant and Shipley, 1939)

This is a very complex system with three hydrates of simple salts and six double salts of which two at least must be regarded as representing series of solid solutions.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NiCl ₂	CdCl ₂		NiCl ₂	CdCl ₂	
0.0	54.62	Cd2½	23.91	36.30*	S.S. + 2.1.6
7.61	46.98	"	24.85	35.07*	2.1.6
0.0	58.10*	Cd1	25.96	33.52*	"
3.97	52.64*	"	29.10	29.84*	"
8.56	47.68	"	29.23	29.54*	"
11.37	45.85*	"	31.11	27.70*	3.2.14
11.84	44.91	" + Cd2½	31.82	26.72*	"
17.52	42.54*	S.S.	34.50	24.09*	"
19.00	40.62*	"	24.04	36.64*	S.S. + 1.2.12
20.41	40.05*	"	23.55	35.94*	1.2.12
22.68	37.69*	"	24.47	33.28*	"
29.13	32.20*	"	25.02	31.81*	" + 4.1.10
12.7	45.2	Cd1 + 4.1.10	25.01	31.37'	" + 2.1.12
13.26	44.51	4.1.10	25.72	30.30	"
13.99	43.45	"	25.93	29.40	"
16.83	39.85	4.1.10	28.55	23.35	"
18.09	38.35	"	34.91	11.01	"
23.18	33.21*	"	43.31	2.47*	"
19.13	37.83*	2.1.12	35.56	9.96	" + N16
21.69	34.51*	"	35.73	9.44	N16
22.3	33.8	" + 4.1.10	35.39	4.55	"
24.23	32.05	"	39.58	0.0	"

* = Metastable

Cd2½ = CaCl₂·2½H₂O; Cd1 = CdCl₂·H₂O; S.S. = Solid Solution, (Cd,Ni)Cl₂·2½H₂O; 4.1.10 = 4CdCl₂·NiCl₂·10H₂O; 2.1.12 = 2CdCl₂·NiCl₂·12H₂O; 2.1.6 = 2CdCl₂·NiCl₂·6H₂O; 3.2.14 = 3CdCl₂·2NiCl₂·14H₂O; 1.2.12 = CdCl₂·2NiCl₂·12H₂O; N16 = NiCl₂·6H₂O.

Cd CADMIUM

SOLUBILITY OF ANHYDROUS CADMIUM CHLORIDE IN PURE METHYL ALCOHOL
(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1926)

t°	Gms. CdCl ₂ per 100 gms. CH ₃ OH	Solid Phase
15.5	1.71*	-
20	2.15	CdCl ₂ ·3CH ₃ OH
30	2.66	CdCl ₂ ·2CH ₃ OH
40	3.44	"
50	4.44	CdCl ₂ ·2CH ₃ OH (?)
CRIT. TEMP.	1.5 †	-

c1 *de Bruyn, 1892
†Centnerszwer, 1910

SOLUBILITY OF ANHYDROUS CADMIUM CHLORIDE IN PURE ETHYL ALCOHOL
(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1926)

t°	Gms. CdCl ₂ per 100 gms. C ₂ H ₅ OH	Solid Phase	t°	Gms. CdCl ₂ per 100 gms. C ₂ H ₅ OH	Solid Phase
10	1.30	CdCl ₂ ·1½C ₂ H ₅ OH	50	2.28	CdCl ₂ ·1½C ₂ H ₅ OH
15.5	1.52*	-	60	2.78	"
20	1.48	"	65	2.86	CdCl ₂
30	1.66	"	70	2.53	"
40	1.91	"			

*de Bruyn, 1892

SOLUBILITY OF CADMIUM CHLORIDE IN PYRIDINE
(Mason and Mathews, 1925)

t°	Gms. CdCl ₂ per 100 gms. sat. sol.	Solid Phase	t°	Gms. CdCl ₂ per 100 gms. sat. sol.	Solid Phase
0	0.46	CdCl ₂ ·6C ₅ H ₅ N	25	0.70	CdCl ₂ ·2C ₅ H ₅ N
4	0.78	"	30	0.67	"
7.2	0.91	"	40	0.61	"
9.0 tr. pt.	0.97	" + CdCl ₂ ·2C ₅ H ₅ N	60	0.54	"
10.0	0.93	CdCl ₂ ·2C ₅ H ₅ N	80	0.49	"
15.0	0.80	"	100	0.50	"

100 gms. sat. sol. of CdCl₂ in selenium oxychloride (SeOCl₂) contain 0.15 gms. CdCl₂ at 25°. (Wise, 1923)

CADMIUM Pyridine CHLORIDE $\text{CdCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$

Cl

SOLUBILITY OF CADMIUM PYRIDINE CHLORIDE IN SEVERAL SOLVENTS
(Kragen, 1916)

Solvent	t°	Gms. $\text{CdCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$ per 100 gms. sat. sol.
Water	20	0.2893
Alcohol	18	0.0295
"	25	0.0351
Ether	27	0.0037
50% alcohol + 50% water	18	0.2265
" " "	27	0.2343
75% " + 25% Ether	28	0.0265
50% " + 50%	28	0.0171
Pyridine	22	1.347

A method for the determination of pyridine based upon the time of appearance of a precipitate produced by CdCl_2 or HgCl_2 in aqueous solutions of pyridine is described by Ionescu and Slusauschi, 1933.

THE SYSTEM CADMIUM CHLORIDE - DIOXANE - WATER AT 25°
(Weicksel and Lynch, 1950)Solid Phase $\text{CdCl}_2 \cdot (\text{C}_2\text{H}_4)_2\text{O}_2$

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
CdCl_2	Dioxane	CdCl_2	Dioxane	CdCl_2	Dioxane
54.21	0.43*	1.74	29.80	.11	75.62
52.07	0.50	1.01	39.00	.06	80.95
48.01	0.60	0.82	44.55	0.03	86.24
28.08	1.00	0.48	54.61	0.0	90.32
13.29	3.82	.36	57.00	0.0	94.87
5.42	10.55	.19	67.27	0.0	97.48
2.88	20.70				

*Solid Phase $\text{CdCl}_2 \cdot 2.5\text{H}_2\text{O} + \text{CdCl}_2 \cdot (\text{C}_2\text{H}_4)_2\text{O}_2$

100 gms. benzonitrile dissolve 0.063 gm. CdCl_2 at 18°. (Neumann, 1914)

CADMIUM Choline CHLORIDE $(\text{CH}_3)_3\text{NClC}_2\text{H}_4\text{OH} \cdot \text{CdCl}_2$

Cl

0.01 gms. are dissolved in 100 ml. of solution in water at room temperature. (Seaman, Hugonet, and Leibmann, 1949).

Cd CADMIUM

Cl CADMIUM Thiourea CHLORIDE $\text{CdCl}_2 \cdot 2\text{CS}(\text{NH}_2)_2$

One liter sat. solution in water contains 29.33 gm. $\text{CdCl}_2 \cdot 2\text{CS}(\text{NH}_2)_2$ at room temperature. (Walter, Adler and Reimer, 1934)

Melting point data are given for the following:

Cadmium Chloride	+ Cadmium Iodide	(Nacken, 1907 (c); Ruff and Plato, 1903)
"	" + Cadmium Fluoride	(Ruff and Plato, 1903)
"	" + Cadmium Sulfate	(" " ; Bergman and Bakutskaya, 1955; Lesnykh and Bergman, 1953)
"	" + Calcium Chloride	(Sandonnini, 1911, 1914; Menge, 1911)
"	" + Cuprous Chloride	(Herrmann, 1911)
"	" + Lead Chloride	(Sandonnini, 1912, 1914; Herrmann, 1911, Tarasova, 1947)
"	" + Magnesium Chloride	(Menge, 1911)
"	" + Manganese Chloride	(Sandonnini, 1914; Sandonnini and Scarpa, 1911)
"	" + Mercuric Iodide	(Sandonnini, 1912)
"	" + Potassium Chloride	(Brand, 1911, Dergunov, 1949)
"	" + Sodium Chloride	(" " ; Bergman and Bakutskaya, 1955)
"	" + " " + Potassium Chloride	(Brand, 1911)
"	" + Strontium Chloride	(Sandonnini, 1911; 1914)
"	" + Thallium Chloride	(Korring, 1914; Sandonnini, 1913; Belyaev, 1953)
"	" + Tin (ous) Chloride	(Herrmann, 1911; Sandonnini, 1914)
"	" + Zinc Chloride	(Herrmann, 1911)
"	" + Lithium Chloride	(Ferrari-Baroni, 1926; Dergunov, 1949; Gromakov, 1950; Lesnykh and Bergman 1953)
"	" + Rubidium Chloride	(Hoffman, 1927; Dergunov, 1949)
"	" + Caesium Chloride	(Dergunov, 1949)
"	" + Indium III Chloride	(Vovkogen and Fialkov, 1945)
$\text{CdCl}_2 + \text{Li}_2\text{SO}_4 \rightleftharpoons \text{CdSO}_4 + 2\text{LiCl}$		(Lesnykh and Bergman, 1953)
$\text{CdCl}_2 + \text{Na}_2\text{SO}_4 \rightleftharpoons \text{CdSO}_4 + 2\text{NaCl}$		(Bergman and Bakutskaya, 1955)
$\text{CdCl}_2 + \text{PbCl}_2 + \text{KCl}$		(Tarasova, 1947)
$\text{CdCl}_2 + \text{PbCl}_2 + \text{TlCl}$		(Bergman and Tapchanyara, 1941)
$\text{CdCl}_2 + \text{RbCl} + \text{CsCl}$		(Dergunov, 1949)

Cl Basic CADMIUM-CHLORIDES $\text{Cd}(\text{OH})_x\text{Cl}_y$

(Data of Feitknecht and Reinmann, 1951)

Salt	Concentration Solubility Product	Salt	Concentration Solubility Product
$\text{Cd}(\text{OH})\text{Cl}$	1.1×10^{-10}	$\text{Cd}(\text{OH})_{1.70}\text{Cl}_{0.30}$	4.48×10^{-14}
$\text{Cd}(\text{OH})_{1.25}\text{Cl}_{0.75}$	6.7×10^{-12}	$\text{Cd}(\text{OH})_{1.80}\text{Cl}_{0.20}$	2.40×10^{-14}
$\text{Cd}(\text{OH})_{1.33}\text{Cl}_{0.67}$	$\sim 1 \times 10^{-11}$	$\text{Cd}(\text{OH})_{1.95}\text{Cl}_{0.05}$	8.81×10^{-15}
$\text{Cd}(\text{OH})_{1.50}\text{Cl}_{0.50}$	6.8×10^{-13}	$\text{Cd}(\text{OH})_2$	7.60×10^{-15}

CADMIUM CHLORATE $\text{Cd}(\text{ClO}_3)_2$

ClO

SOLUBILITY IN WATER
(Meusser, 1902)

t°	Gms. $\text{Cd}(\text{ClO}_3)_2$ per 100 Gms. Solution	Mols. $\text{Cd}(\text{ClO}_3)_2$ per 100 Mols. H_2O	Solid Phase
- 6.5	26.18	3.07	Ice
-13.0	52.36	9.52	"
-20.0	72.10	22.47	$\text{Cd}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$
-15.0	72.53	22.87	"
± 0	74.95	25.92	"
18	76.36	27.98	"
49	80.08	34.82	"
65	82.95	42.14	"

Density of the sat. solution at 18° = 2.284.

CADMIUM PERCHLORATE $\text{Cd}(\text{ClO}_4)_2$

ClO

SOLUBILITY IN WATER
(Hering and Leray, 1939)

t°	Gms. $\text{Cd}(\text{ClO}_4)_2$ per 100 gms. sat. sol.	Density	Solid Phase
- 4,4	18,0	-	Ice
- 10,1	28,1	-	
- 18,9	35,9	-	
- 29,7	42,1	-	
- 33,9	43,5	-	
- 37,8	45,0	-	
- 42,5	46,5	-	
- 48,1	48,0	-	
- 55,5	45,5	-	Ice + $\text{Cd}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$
- 66,5	51,2	-	
- 61,2	51,6	-	$\text{Cd}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$
- 49,5	52,3	-	
- 37,3	53,25	-	
- 34,3	53,6	-	
- 14,8	55,2	-	
- 7,2	55,85	-	
+ 8,7	57,2	1,739	
+ 20,0	58,25	1,750	
+ 30,0	59,15	1,760	
40,0	60,10	1,771	
50,0	61,10	1,783	
60,0	62,15	1,708	
70,0	63,2	1,813	
80,0	64,35	1,830	
90,0	65,6	1,851	
100,0	66,9	1,874	
110,1	68,45	1,902	
120,3	70,4	1,943	

(Cont.)

Cd CADMIUM

t°	Gms. Cd(ClO ₄) ₂ per 100 gms. sat. sol.		Density	Solid Phase
129,4	74,23	-	}	Cd(ClO ₄) ₂ ·6H ₂ O
126,1	76,3	2,115		
115,2	78,2	2,190		
100,0	79,85	2,251		
80,0	81,1	2,321		
60,0	82,25	2,380		
58,5	82,35	-	-	Cd(ClO ₄) ₂ ·6H ₂ O + Cd(ClO ₄) ₂ ·2H ₂ Oα
ClO	58,7	82,4	-	Cd(ClO ₄) ₂ ·2H ₂ Oα
	64,1	82,7	-	
	65,0	82,8	-	
66,0	82,85	-	-	Cd(ClO ₄) ₂ ·2H ₂ Oα + Cd(ClO ₄) ₂ ·2H ₂ Oβ
60,0	82,65	-	}	Cd(ClO ₄) ₂ ·2H ₂ Oβ
67,0	82,9	-		
80,0	83,4	2,407		
100,0	84,25	2,419		
115,2	85,0	2,435		
126,1	85,6	2,447		
128,7	85,8	2,451		
148,7	87,35	2,496		
153,3	87,7	2,519		
157,9	89,63	-		
155,9	90,6	-	}	Cd(ClO ₄) ₂
150,0	91,5	2,676		
144,4	92,0	-	-	Cd(ClO ₄) ₂ ·2H ₂ Oβ + Cd(ClO ₄) ₂
155,9	92,3	-	}	Cd(ClO ₄) ₂
173,3	92,8	-		
189,5	93,3	-		
247,0	95,3	-		

Results which disagree with these are given by Makarov and Volnov, 1951:

t°	Gms. Cd(ClO ₄) ₂ per 100 gms. sat. sol.
55	71.75
75	77.83

SOLUBILITY OF Cd(ClO₄)₂ IN ORGANIC SOLVENTS

At room temperature, 80 gms. Cd(ClO₄)₂ dissolve in 100 cc of furfural and 145 gms. in cellosoave (Chaney and Mann, 1931)

CADMIUM Hexa Antipyrine PERCHLORATE $[\text{Cd}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$ ClO

100 cc sat. solution in water contain 7.54 gm. $[\text{Cd}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$ at 20°. (Wilke-Dorfurt and Schliephake, 1929)

CADMIUM FLUORIDE CdF_2

F

SOLUBILITY OF CADMIUM FLUORIDE IN WATER

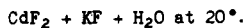
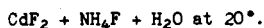
t°	Gms. CdF_2 per 100 cc sat. solution	Authority
20	4.06	(Kurtenacker, Finger and Hey, 1933)
25	4.35	(Jaeger, 1901)
25	0.622	(Carter, 1928)
100	1.8	(Nuka, 1929)

SOLUBILITY OF CADMIUM FLUORIDE IN AQUEOUS SOLUTIONS
OF HYDROFLUORIC ACID AT 20°
(Kurtenacker, Finger and Hey, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase
HF	CdF_2	
0.9	5.0	CdF_2
24.4	11.2	"
38.6	3.0	"

100 cc of sat. solution in 1.08 normal HF contain 5.62 gms. CaF_2 at 25°. (Jaeger, 1901).

Equilibrium in the Systems:



(Kurtenacker, Finger and Hey, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdF_2	NH_4F		CdF_2	NH_4F	
4.0	1.6	CdF_2	2.4	3.4	Mixed Crystals
2.4	5.4	"	0.6	13.6	"
1.8	12.3	"	0.18	24.1	"
0.4	20.8	$\text{CdF}_2 \cdot 2\text{NH}_4\text{F} \cdot 2\text{H}_2\text{O}$	0.05	32.5	"
0.87	28.9	"	0.024	33.1	"
0.57	40.9	"	-	41.2	"

Cd CADMIUM

SOLUBILITY OF CdF_2 IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

t°	-23.2°	-4.4°	+14.2
Gms. CdF_2 per 100 gms. HF	0.189	0.198	0.201

Solubility of CaF_2 in Liquid Sulfur Dioxide at 25°: 0.08 gms. dissolve in 100 gms. liquid SO_2 at 25°. (Watt, Jenkins and Robertson, 1950)

Fusion-point data have been determined for:

$\text{CdF}_2 + \text{CdI}_2$	(Ruff and Plato, 1903)
" + NaF	(Puschin and Baskov, 1913)

F CADMIUM Hexa Antipyrine FLUOBORATE $[\text{Cd}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_2$

100 cc sat. solution in water contain 9.9 gm. $[\text{Cd}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_2$ at 20°. (Wilke-Dorfurt and Mureck, 1929)

I CADMIUM IODIDE CdI_2

SOLUBILITY OF CADMIUM IODIDE IN WATER

(Cohen, Hetterschij and Moesveld, 1920; Hering, 1936; results for the ice curve Guempel, 1929; results above 100° Benrath, Gjeddebo, Schiffers and Wunderlich, 1937)

t°	d. of sat. sol.	Gms. CdI_2 per 100 gms. solution	Solid Phase	t°	d. of sat. sol.	Gms. CdI_2 per 100 gms. solution	Solid Phase
- 0.2	-	5.37	Ice	25	-	46.295	CdI_2
- 0.8	-	15.0	"	27.5	-	46.540	"
- 1.3	-	20.11	"	30.0	-	46.793	"
- 2.0	-	25.50	"	32.5	-	47.039	"
- 3.4	-	33.0	"	35.0	-	47.296	"
- 4.0	-	36.8	"	37.5	-	47.573	"
- 4.7	-	39.66	"	40.0	1.619	47.95	"
- 5.45	-	42.19	"	60.	1.646	50.1	"
- 6.4	-	45.60	"	80	1.682	52.6	"
- 5.3	-	42.05	" + $\text{CdI}_2 \cdot 4\text{H}_2\text{O}$	100	1.726	55.55	"
- 3.5	-	43.35	$\text{CdI}_2 \cdot 4\text{H}_2\text{O}$	128	-	59.1	"
- 2.0	-	44.4	"	179	-	66.7	"
- 2.9	-	43.75	" + CdI_2	211	-	73.3	"
- 1.8	-	43.85	CdI_2	243	-	79.5	"
0	1.567	44.05	"	269	-	85.4	"
+15	-	45.363	"	293	-	90.5	"
20	1.590	45.85	"	318	-	94.8	"
22.5	-	46.053	"	385(M.pt.)	-	100.0	"

SOLUBILITY OF CADMIUM IODIDE IN WATER AND DEUTERIUM OXIDE
(Eddy and Menzies, 1940)

See Note page 336. The authors determined the solubility of Cadmium Iodide in Water and Deuterium Oxide at several temperatures and present rounded values read from a plot of their data. The results in Water agree well with those previously reported, and the authors' original four points are given below. In Deuterium Oxide eleven evenly spaced determinations were made, and the rounded values at integral temperatures listed by the authors are tabulated below. The solid phase was CdI_2 throughout.

Gms. CdI ₂ per 100 t° gms. H ₂ O	Gms. CdI ₂ per 100 t° gms. D ₂ O	Gms. CdI ₂ per 100 t° gms. D ₂ O	Gms. CdI ₂ per 100 t° gms. D ₂ O	Gms. CdI ₂ per 100 t° gms. D ₂ O					
Results in H ₂ O		Results in D ₂ O (99.4%)							
76.9	109.1	0	49.4	40	62.6	80	81.1	120	106.8
99.1	125.6	5	50.7	45	64.6	85	83.7	125	110.7
131.2	150.9	10	52.4	50	66.6	90	86.7	130	114.7
155.1	177.6	15	54.0	55	68.9	95	89.6	135	118.9
		20	55.7	60	71.2	100	92.6	140	123.6
		25	57.3	65	73.5	105	95.9	145	128.2
		30	59.0	70	75.8	110	99.2	150	133.1
		35	60.6	75	78.4	115	102.8		

THE SYSTEM CADMIUM IODIDE - MERCURIC IODIDE - WATER
(Hietanen and Sillen, 1947)

Solution		Solid		Solution		Solid	
Wt. % CdI_2	Wt. % HgI_2	Wt. % CdI_2	Wt. % HgI_2	Wt. % CdI_2	Wt. % HgI_2	Wt. % CdI_2	Wt. % HgI_2
Results at 50°				Results at 100°			
48.4	0.0	100.0	0.0	55.0	0.0	100.0	0.0
44.8	3.4	95.1	4.9	55.3	4.3	78.1	21.9
43.5	3.5	70.1	29.9	53.2	3.7	92.8	7.2
43.5	3.3	47.6	52.4	53.1	3.9	70.3	29.7
43.2	4.1	49.7	50.3	52.5	4.2	68.6	31.4
38.0	5.5	26.1	73.9	51.3	4.7	50.6	49.4
34.1	6.2	16.4	83.6	49.8	5.4	58.2	41.8
32.5	6.6	10.7	89.3	46.0	7.0	33.7	66.3
28.0	6.7	10.5	89.5	46.0	7.0	35.2	64.8
24.4	6.6	4.8	95.2	40.6	8.3	17.8	82.2
19.9	6.6	3.9	96.1	40.3	8.2	21.0	79.0
13.7	5.8	2.4	97.6	35.3	9.2	0.0	100.0
8.4	3.7	1.5	98.5	34.0	9.5	11.1	88.9
				26.3	9.3	17.8	82.2
				22.5	9.0	2.6	97.4
				12.6	7.0	0.4	99.6
				10.3	5.8	42.6	57.4
				6.5	3.6	0.0	100.0
				0.0	0.2	0.0	100.0
Results at 75°				The invariant solutions have the following compositions:			
49.4	3.7	99.3	0.7	50°	43.8% CdI_2	3.6% HgI_2	
49.8	3.7	79.4	20.6	75°	49.5% "	3.5% "	
49.6	3.3	65.0	35.0	100°	53.0% "	4.0% "	
49.0	3.3	49.1	50.9				
44.3	4.9	33.0	67.0				
38.9	6.8	21.9	78.1				
33.0	7.6	11.2	88.8				
24.0	7.6	3.6	96.4				
12.8	5.5	0.7	99.3				
6.3	3.5	1.0	99.0				

The limit of the solubility of CdI_2 in HgI_2 was found to be:

50°	40 ± 8% CdI_2	
75°	45 ± 8% "	(in the system $\text{CdI}_2 + \text{HgI}_2 + \text{H}_2\text{O}$)
100°	55 ± 8% "	

Cd CADMIUM

EQUILIBRIUM IN THE SYSTEM CADMIUM IODIDE, POTASSIUM IODIDE AND WATER
(Hering, 1936)

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CdI ₂	KI				CdI ₂	KI	
-26.8	33.0	40.3	Ice	20	1.810	42.3	15.8	CdI ₂
-23.2	39.3	35.7	"	"	2.353	45.1	31.95	"
-17.5	29.2	35.8	"	"	2.719	46.95	38.2	1.1.1
-16.7	41.0	27.9	"	"	2.624	41.05	43.0	KI
-11.4	36.2	24.6	"	"	2.164	26.65	47.25	"
-10.9	24.2	29.5	"	"	1.986	18.1	50.8	"
- 7.1	29.8	20.3	"	82	3.168	52.05	41.2	1.2.½
- 5.0	21.0	19.1	"	95	-	54.75	39.25	1.1.1
- 4.8	15.8	19.2	"	100	1.927	49.2	16.5	CdI ₂
- 2.5	18.5	12.6	"	"	2.335	50.4	28.5	"
-26.7	33.5	41.25	KI	"	-	55.5	35.8	"
-24.4	41.95	36.15	2.3.4	"	3.191	56.2	37.4	1.1.1
-20.7	39.2	40.05	1.2.3	"	3.235	56.0	38.25	"
-20.1	42.25	35.2	1.1.1	"	-	54.95	39.75	1.2.½
-14.4	42.15	28.9	CdI ₂ ·4H ₂ O	"	-	53.1	41.1	"
- 8.3	40.5	18.0	CdI ₂	"	2.417	34.8	47.7	KI
0.0	44.75	36.45	1.1.1	"	2.009	44.35	58.8	"

2.3.4 = 2CdI₂·3KI·4H₂O; 1.2.3 = CdI₂·2KI·3H₂O; 1.1.1 = CdI₂·KI·H₂O;
1.2.½ = CdI₂·2KI·½H₂O.

COMPOSITIONS OF THE INVARIANT SOLUTIONS:
(Hering, 1936)

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdI ₂	KI	
-19.3	-	42.4	29.75	Ice + CdI ₂ ·4H ₂ O + 1.1.1
-14.3	-	42.6	30.6	CdI ₂ ·4H ₂ O + 1.1.1
-11.7	-	43.2	31.25	" "
-10.9	-	43.35	31.4	" + CdI ₂ + 1.1.1
- 9.85	-	43.5	31.65	CdI ₂ + 1.1.1
- 5.1	-	44.05	32.45	" "
0	2.420	44.7	33.4	" "
+20	2.575	47.1	35.0	" "
40	2.706	49.4	35.7	" "
60	2.836	51.4	36.25	" "
80	2.982	53.9	36.5	" "
100	-	56.4	36.6	" "
-25.3	-	41.7	35.25	Ice + 1.1.1 + 2.3.4
-24.1	-	41.9	35.4	1.1.1 + 2.3.4
-11.8	-	43.7	37.0	" "
0	2.644	45.15	38.2	" "
-27.7	-	41.55	36.6	Ice + 2.3.4 + 1.2.3
-27.0	-	41.75	36.7	2.3.4 + 1.2.3
-26.6	-	41.8	36.95	" "

(Cont.)

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		CdI ₂	KI	
-24.4	-	42.0	37.2	2.3.4 + 1.2.3
-18.6	-	43.0	38.0	" "
-15.8	-	43.3	38.35	" "
-14.2	-	43.3	38.45	" + 1.2.2
0.0	2.672	45.05	38.9	" "
10	2.738	46.25	39.15	" "
10	2.740	46.3	39.15	1.1.1 + 2.3.4 + 1.2.2
20	2.793	47.15	39.45	1.1.1 + 1.2.2
40	2.899	48.7	40.05	" "
60	3.022	50.4	40.5	" "
75	3.153	51.9	41.0	" "
76.3	3.165	52.1	41.05	" " + 1.2.½
78	3.172	52.4	40.9	" + 1.2.½
90	3.235	53.9	40.15	" "
100	3.307	55.75	39.2	" "
-30.2	-	35.15	40.8	Ice + 1.2.3 + KI
-28.0	-	35.7	41.0	1.2.3 + KI
-23.4	-	36.85	41.25	" "
-18.9	-	37.95	41.5	" "
-17.3	-	38.35	41.6	1.2.3 + 1.2.2 + KI
-24.3	-	37.4	41.25	1.2.2 + KI
-13.8	-	38.7	41.8	" "
0	2.583	40.4	42.3	" "
20	2.693	42.5	42.8	" "
40	2.795	44.35	43.2	" "
60	2.907	46.2	43.5	" "
80	-	48.6	43.6	" "
81.4	-	48.9	43.65	" + 1.2.½ + KI
83	-	48.95	43.65	1.2.½ + KI
100	3.120	49.65	43.7	" "

1.1.1 = CdI₂·KI·H₂O; 2.3.4 = 2CdI₂·3KI·4H₂O; 1.2.3 = CdI₂·2KCl·3H₂O;
1.2.2 = CdI₂·2KI·2H₂O; 1.2.½ = Cd₂·2KI·½H₂O.

CADMIUM POTASSIUM IODIDES

I

SOLUBILITY OF EACH IN WATER
(Hering, 1936)

t°	Gms. anhydrous double salt per 100 gms. sat. sol.	Solid Phase	t°	d. of sat. sol.	Gms. anhydrous double salt per 100 gms. sat. sol.	Solid Phase
-27.5	77.9	Ice + 1.2.3	0	2.638	83.45	1.2.2
-23.3	79.2	1.2.3	20	2.736	85.75	"
-15.3	81.3	" + 1.2.2	40	2.825	87.8	"
-29.3	78.8	Ice + 1.2.2	60	2.928	89.9	"
-19.1	80.65	1.2.2	76	3.000	91.7	"
-44.3	81.45	"				

1.2.3 = CdI₂·2KCl·3H₂O; 1.2.2 = CdI₂·2KCl·2H₂O.

Cd CADMIUM

CADMIUM AMMONIUM IODIDES (Mono and Di)

SOLUBILITY OF EACH SEPARATELY IN WATER, ETC.
(Rimbach, 1905; Eder, 1876)

Cd. Mono Ammonium Iodide				Cd. Diammonium Iodide		
Solvent	t°	Gms. CdI ₂ ·NH ₄ I per 100 Gms.		t°	Gms. CdI ₂ ·2NH ₄ I per 100 Gms.	
		Solution	Solvent		Solution	Solvent
Water	15	52.6	111	14.5	85.97	611.6
Abs. Alcohol	15	53	113	15	59	143
Abs. Ether	15	29.4	41.7	15	10	11

I CADMIUM SODIUM IODIDE CdI₂·2NaI·6H₂O

100 gms. Water sat. with the salt contain 158.8 gms. CdI₂·2NaI at 15°.

" " Alcohol " " " " 116.2 " " "

" " Ether " " " " 9.9 " " "

(Eder, 1876)

A phase diagram for the system CdI₂-Sucrose-Water at 30° is drawn by Kelly, 1954. No compounds are formed, a solution saturated with both components contains 52.9% Sucrose, 26.0% CdI₂.

SOLUBILITY OF CADMIUM IODIDE IN VARIOUS ALCOHOLS

(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928; Miyosi and Hagisawa, 1941; Muchin, 1913, see also Timofeiew, 1894)

The data of Miyosi and Hagisawa are from EMF measurements.

t°	CH ₃ OH		C ₂ H ₅ OH			C ₃ H ₇ OH	iso-C ₃ H ₇ OH
	(LBGBJ)	(M)	(M & H)	(LBGBJ)	(M)	(M)	(M)
Gms. CdI ₂ per 100 gms. sat. sol.							
0	-	67	-	-	33.5	16.0	36.9
5	-	-	-	-	41	22.0	36.9
10	67.4	68	-	(50.5) ^a	54 ^b	28.5 ^c	37.2
20	67.4	69	52.55	52.5	53	41.5 ^d	37.3
25	-	69.5	52.34	-	52.2	37.8	37.3
30	67.4	70	52.13	50.0	51.5	35.5	37.3
35	-	-	51.94	-	-	-	-
40	67.3	71	51.77	51.0	50.8	34.5	37.3
42	-	-	-	-	-	-	-
50	67.5	72.5	-	50.6	50	34.0	37.3
60	67.6	-	-	50.9	-	-	-
70	67.9	-	-	50.9	-	-	-
80	-	-	-	51.0	-	-	-

^aValue of Eder, 1876 at 15°

^cTimofeiew, 1891 given 28.9

^bAt 12.6° (= Tr. Temp.)

^d(Transition Temp.)

DISTRIBUTION OF CdI_2 BETWEEN AMYL ALCOHOL AND WATER AT 30°
(Dahr and Datter, 1913)

Gms. per 100 cc			Gms. per 100 cc		
H_2O	Alcohol	$\frac{c}{c'}$	H_2O	Alcohol	$\frac{c}{c'}$
Layer (c)	Layer (c')		Layer (c)	Layer (c')	
47.75	43.00	1.11	6.23	4.94	1.33
29.08	25.86	1.13	2.42	1.54	1.55
14.46	12.55	1.15	1.93	1.10	1.76
10.69	8.94	1.20	1.76	0.94	1.87

EQUILIBRIUM IN THE SYSTEM CADMIUM IODIDE, ETHER AND WATER
(Guempel, 1929)

The influence of CdI_2 upon the mutual solubility of water and ether was determined by adding, on the one hand, successive amounts of ether to mixtures of known amounts of water and CdI_2 , to appearance of clouding; and on the other hand, adding water to given mixtures of ether and CdI_2 . The following results were obtained at 20° .

Percentage composition of the aqueous phase			Percentage composition of the ethereal phase		
CdI_2	H_2O	$(\text{C}_2\text{H}_5)_2\text{O}$	CdI_2	H_2O	$(\text{C}_2\text{H}_5)_2\text{O}$
0.0	93.50	6.50	0.0	1.20	98.80
10.50	82.66	6.90	11.32	5.68	83.00
25.50	67.20	7.20	22.20	10.50	67.50
34.45	53.05	12.50	28.83	10.15	66.02
39.78	38.00	22.22	34.81	14.14	50.78

The tie lines joining the conjugated layers were determined by analyzing (for CdI_2) a series of immiscible layers representing points in the curve drawn from the above results. These tie lines showed that the critical mixture at 20° is composed of 39.45% CdI_2 , 35.31% H_2O and 25.24% $(\text{C}_2\text{H}_5)_2\text{O}$, which corresponds to a critical solvent composed of 58.33% H_2O and 41.67% $(\text{C}_2\text{H}_5)_2\text{O}$. By adding increasing amounts of CdI_2 to such critical solvent it was found that the critical solution temperature rose with increasing concentrations of CdI_2 . By extrapolation of these results to zero concentration of CdI_2 the lower critical solution temperature of a mixture of ether and water was found to be at -70° .

A series of determinations are also given showing the influence of temperature upon the solubility of ether in aqueous solutions of CdI_2 varying from 41.1% CdI_2 to saturation of the salt. Results are also given for the influence of CdI_2 upon the freezing-point of various mixtures of water and ether and of ether upon the f. pt. of mixtures of water and CdI_2 ; results are also given for the variation of the binary eutectic points of water-ether mixtures in contact with an excess of CdI_2 .

Cd CADMIUM

SOLUBILITY OF CADMIUM IODIDE IN MIXTURES OF WATER AND ETHYL ETHER AT 20°
(Guempel, 1929)

Within certain limits of temperature, the addition of CdI_2 renders water and ether miscible in all proportions.

	Gms. Ether per 100 gms. solvent	Gms. CdI_2 per 100 gms. solvent	Percentage Composition of Ternary Mixture		
			CdI_2	H_2O	$(\text{C}_2\text{H}_5)_2\text{O}$
I	0.0	85.53	46.10	53.30	0.0
	16.09	93.61	48.35	43.34	8.31
	29.70	97.98	49.49	35.51	15.00
	38.67	99.96	49.99	30.67	19.34
	65.96	107.94	51.91	16.37	31.72
	79.08	104.40	51.09	10.23	38.69
	84.90	89.93	47.35	7.95	44.70
	90.20	72.00	41.86	5.70	52.44
	96.00	27.54	21.60	3.14	75.26
	100.0	0.07	0.07	0.0	99.95

SOLUBILITY OF CADMIUM IODIDE IN ETHYL ETHER CONTAINING WATER AT 12°
(Tyrer, 1911)

Gms. H_2O per
100 gms.
ether + $\text{H}_2\text{O} \rightarrow$ 0.0 0.10 0.30 0.50 0.70 0.90 1.00 1.10 1.14 (sat.)

Gms. CdI_2 per
100 gms.
solvent \rightarrow 0.143 0.78 2.07 3.36 4.77 6.46 7.30 8.27 8.68

DISTRIBUTION OF CADMIUM IODIDE BETWEEN WATER AND ETHYL ETHER AT 30°
(Dahr and Datter, 1913)

Gms. per 100 cc			Gms. per 100 cc		
H_2O Layer (c)	Ether Layer (c')	$\frac{c}{c'}$	H_2O Layer (c)	Ether Layer (c')	$\frac{c}{c'}$
37.18	8.38	4.43	9.89	1.83	5.40
30.03	6.61	4.54	7.68	1.06	5.52
15.38	3.09	4.97	4.03	0.73	5.60
12.60	2.38	5.29	3.10	0.51	6.03

Cadmium iodide is "completely" extracted from 6.9N HCl by shaking with ether. (Kitahara, 1948)

SOLUBILITY OF CADMIUM IODIDE IN ANHYDROUS ETHYL ETHER

t°	Gms. CdI ₂ per 100 gms. (C ₂ H ₅) ₂ O	Author
0	0.148	(Linebarger, 1895)
12	.143	(Tyrer, 1911)
15.5	.198	(Linebarger, 1895)
20	.065 (!)	(Guempel, 1929)
20.3	.247	(Linebarger, 1895)

The higher results found by Linebarger and Tyrer may be caused by traces of water.

100 gms. abs. ethyl alcohol dissolve 41.7 gms. CdI₂·2KI at 15°. (Eder, 1876)

100 gms. abs. ether dissolve 3.9 gms. CdI₂·2KI at 15°. (Eder, 1876)

SOLUBILITY OF CADMIUM IODIDE IN VARIOUS ORGANIC SOLVENTS

Solvent	t°	Gms. CdI ₂ per 100 gms. solvent	Author
Acetone	18	25. (d ₁₈ = .994)	(Naumann, 1904)
	25	42.8	(Zapata and Zapata, 1930)
	25	40.98	(Spinoglio and Reveuna, 1935)
Benzonitrile	18	1.63	(Naumann, 1914)
Benzene	16	0.047	(Linebarger, 1895)
	35	0.094	(" ")
Ethyl Acetate	0	4.73	(Muchin, 1913)
	13	1.67	(" ")
	18	1.84 (d ₁₈ = .9145)	(Naumann, 1910)
	26	2.02	(Muchin, 1913)

Gms. CdI₂ per 100 Gms. Sat. Sol.

	0°	13.0°	26.0°	
Methyl formate	0.84	0.75	0.66	(Muchin, 1913)
Ethyl formate	1.16	1.05	0.77	
Propyl formate	2.37	2.07	1.53	

Gms. CdI₂ per 100 Gms.
Sat. Solution in:

		C ₆ H ₅ NH ₂	C ₃ H ₇ N	C ₉ H ₇ N	
Amiline	18	...	0.43	...	(R. Müller, 1924)
Pyridine	40	1.7	...	...
Quinidine	50	2.3	0.1	...	
	60	3.1	0.5	2	(Muchin, 1913)
	70	4	1.7	3.5	
	80	5.1	4.8	5	
	90	6.4	13.4	6.7	
	100	8.4	30	8.3	

Cd CADMIUM

SOLUBILITY OF CADMIUM IODIDE IN MIXTURES OF ORGANIC SOLVENTS
(Muchin, 1913)

Methanol + Chloroform and Ethanol + Chloroform

Composition of Solvent in Mols.	Wt. per cent Alcohol in Solvent	Gms. CdI ₂ per 100 Gms. Sat. Solution at:		
		0°	16.8°	36.8°
1CH ₃ OH + 2CHCl ₃	11.8	11.0	10.4	9.3
1CH ₃ OH + 1CHCl ₃	21.1	22.4	22.3	20.6
1C ₂ H ₅ OH + 2CHCl ₃	16.2	7.5	7.1	6.6
1C ₂ H ₅ OH + 1CHCl ₃	27.8	13.9	14.3	13.6
I 2C ₂ H ₅ OH + 1CHCl ₃	43.5	25.2	24.1	...
xC ₂ H ₅ OH + yCHCl ₃	60.3	34.4	...	...
" " "	91.5	45.4	...	...
1C ₂ H ₅ OH + 2C ₆ H ₆	22.8	17.6	16.3 (16.3°)	15.2 (31.2°)
1C ₂ H ₅ OH + 1C ₆ H ₆	37.1	26.1	26.0 (15.7°)	26.0 (")
2C ₂ H ₅ OH + 1C ₆ H ₆	54.1	33.5	35.3 (15°)	...
xC ₂ H ₅ OH + yC ₆ H ₆	9.8	6.5	...	...

Pyridine + Chloroform
1 mole : 1 molePyridine + Benzene
1 mole : 1 mole

Gms. CdI ₂ per 100 Gms.		Gms. CdI ₂ per 100 Gms.		Gms. CdI ₂ per 100 Gms.		Gms. CdI ₂ per 100 Gms.	
t°	Sat. Sol.	t°	Sat. Sol.	t°	Sat. Sol.	t°	Sat. Sol.
50.1	1.27	63	6.3	57.9	1.77	72.5	32.6
54	1.72	64	8.3	60	2.2	74.0	35.9
56	2.3	64.5	12.35	65	4.2	76	36.3
58	3.0	64	14.8	70	8.1	80	40.8
60	4.0	62	22.0	71	11.5	85	41.6
62	5.6	61.15	24.67	71.5	15.0	90.4	42.67

Experiments by Hedvall, Wallgren, and Mansson (1940) showed that samples of CdI₂ which were irradiated with a Mercury Lamp showed an increase in solubility over the solubility in darkness or after radiation with white light. A mixture of 92 parts by volume of Benzene (Free of unsaturated hydrocarbons) + 8 parts Alcohol (99.5% Ethanol, 0.5% H₂O) was used as solvent. A typical experiment using 6.590 grams CdI₂ showed 0.00355 gms. dissolved before irradiation, and 0.00400 gms. after irradiation.

Spinoglio and Reveuna, 1935 give results for the solubility of Cadmium Iodide in acetone containing different amounts of naphthalene and of diphenyl. It was found that the amount of I₂ dissolved is independent of the presence of these two hydrocarbons.

SOLUBILITY OF CdI₂ IN LIQUID SULFUR DIOXIDE AND HYDRAZINE

100 gms. liquid Sulfur Dioxide, SO₂, dissolve 0.043 gm. CdI₂ at 0°.
(Jander and Ruppold, 1937)

100 cc hydrazine dissolve 84 gms. CdI₂ at 15-20°. (Welsh and Broderson, 1915)

CADMIUM AMMINES $\text{Cd}(\text{NH}_3)_4\text{X}_2$ (NH_3)

Data of Ephraim and Mosimann, 1932 at 11°

Solvent:

Aqueous ammonia of $d_{11} = 0.930$			Equal volumes of aq. ammonia of $d_{11} = 0.943$ and 96% alcohol		
Per liter of sat. solution			Per liter of sat. solution		
Salt	Gms. Cd	G. mol. salt	Salt	Gms. Cd	G. mol. salt
Iodide	1.57	0.014	Iodide	0.71	0.0063
Perchlorate	2.57	0.023	Perchlorate	0.819	0.0073
Bromide	10.98	0.098	Bromide	2.94	0.026
Nitrate	35.36	0.316	Nitrate	15.75	0.140
Sulfate	73.48	0.656	Sulfate	1.04	0.009
Chloride	108.32	0.967	Chloride	23.83	0.213
Perrhenate	...	0.00055*			

In the case of the determinations in mixtures of ammonia and alcohol the solutions were prepared by adding an equal volume of 96% alcohol to the sat. solutions of the salts in aq. ammonia of $d_{11} = 0.930$. The amount of salt which remained in solution was determined.

*(Wilke-Dorfurt and Gunzert, 1933)

SOLUBILITY OF CADMIUM AMMONIUM IODIDE IN NITROBENZENE AND ACETONITRILE
(Fialkov and Shevchenko, 1953)Solid phase $\text{Cd}(\text{NH}_3)_4\text{I}_2$

Moles iodine per mole nitrobenzene	Moles iodine per mole of ammine in sat. sol.	Moles iodine per mole acetonitrile	Moles iodine per mole of ammine in sat. sol.
0.0062	1.90	0.0055	1.00
.0205	2.00	.0093	1.13
.0250	1.96	.0161	1.24

Fusion-point data are given for the following mixtures:

$\text{CdI}_2 + \text{AgNO}_3$	(Bergmann, 1922-4, 1926)
" + CuI	(Herrmann, 1911)
" + HgI_2	(Sandonnini, 1914; Losana, 1926; Pelabon and Lande, 1928)
" + " + PbI_2	(Losana, 1926)
" + KI	(Brand, 1912)
" + NaI	(" ")
$\text{Cd}(\text{NH}_3)_4\text{I}_2 + \text{I}_2$	(Fialkov and Shevchenko, 1952)

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10 CADMIUM IODATE $\text{Cd}(\text{IO}_3)_2$

SOLUBILITY OF CADMIUM IODATE IN SALT SOLUTIONS (Oelke and Wagner, 1939)

Estimated from the curves given by the authors. No temperature given.

Moles KCl per 1000 gms. H_2O	Moles $\text{Cd}(\text{IO}_3)_2$ per 1000 gms. H_2O	Moles MgSO_4 per 1000 gms. H_2O	Moles $\text{Cd}(\text{IO}_3)_2$ per 1000 gms. H_2O
0.02	0.0022	0.02	0.0026
.06	.0031	.06	.0033
.5	.009	.5	.006
1.0	.016	1.0	.0075
2.5	.046	2.5	.009

SOLUBILITY OF $\text{Cd}(\text{IO}_3)_2$ IN KNO_3 SOLUTIONS AT 25° (Saegusa, 1950)

Moles per 1000 gms. H_2O			Moles per 1000 gms. H_2O		
KNO_3	$\text{Cd}(\text{IO}_3)_2$	Density ²⁵ ₄	KNO_3	$\text{Cd}(\text{IO}_3)_2$	Density ²⁵ ₄
0.0	0.002109	0.9985	0.1019	0.003075	1.0052
0.002529	.002171	.9987	.2527	.003708	1.0145
.005058	.002223	.9989	.4896	.004346	1.0287
.01004	.002317	.9991	.7739	.005005	1.0454
.05080	.002730	1.0019	.9995	.005384	1.0578

10 CADMIUM PERIODATES Cd_2HIO_6 $\text{Cd}_5(\text{IO}_6)_2$

Data of Näsänen, 1955

When the molar ratio of NaOH /Periodate is 0 - 1.5, Cd_2HIO_6 precipitates, at ratio 1.6 and above the solid is $\text{Cd}_5(\text{IO}_6)_2$. The concentration K_{sp} at ratio 1.5 is 1.5×10^{-21} ; at ratio 1.6 it is 2×10^{-22} .

MoO CADMIUM MOLYBDATE CdMoO_4

The K_{sp} is 6.05×10^{-8} . (Rao, 1954)

CADMIUM NITRATE $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ SOLUBILITY OF CADMIUM NITRATE IN WATER
(Sieverts and Petzold, 1933)

t°	Gms. $\text{Cd}(\text{NO}_3)_2$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $\text{Cd}(\text{NO}_3)_2$ per 100 gms. sat. sol.	Solid Phase
-7.2	24.2	Ice	50	70.0	$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
-11.5	31.7	"	55	73.0	"
-20.0	41.4	"	58	74.4	"
-16.0 (Eutec)	36.9	" + $\text{Cd}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$	58	78.3	"
-14	38.2	$\text{Cd}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$	55	79.9	"
-10	41.6	"	48.7 tr. pt.	82.3	" + $\text{Cd}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$
-5.2	45.9	"	51	82.7	$\text{Cd}(\text{NO}_3)_2$
-0.3	51.8	"	55	84.4	"
3.5 tr. pt.	56.1	" + $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	56.8	86.0	" + $\text{Cd}(\text{NO}_3)_2$
0.6	55.1	$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	61.0	86.1	$\text{Cd}(\text{NO}_3)_2$
15.0	58.7	"	79	87.0	"
25.0	61.3	"	100	87.2	"
35	64.3	"	130	88.2	"

The density of the sat. solution at 18° is 1.776. (Funk, 1900)

The previous results of Funk, 1900, and the ice curve of Jones and Getman, 1904, differ somewhat from the above very accurate results.

SOLUBILITY OF CADMIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID
(Sieverts and Petzold, 1933a (0, 15, 25°); Malquori, 1928 (20°))

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 Gms. sat. sol.		Solid Phase
$\text{Cd}(\text{NO}_3)_2$	HNO_3		$\text{Cd}(\text{NO}_3)_2$	HNO_3		$\text{Cd}(\text{NO}_3)_2$	HNO_3	
Results at 0°								
51.7	0.1	Cd9	13.2	40.5	Cd4	8.3	70.35	Cd2
50.3	1.85	"	8.0	49.15	"	6.9	72.5	"
48.9	3.75	"	7.25	51.3	"	6.1	74.8	"
48.7	4.3	"	6.1	54.5	"	5.75	75.4	"
47.35	6.53	" + Cd4	4.9	59.7	"	4.75	77.55	"
51.5	3.2*	Cd9	4.4	62.9	"	7.05	75.4*	Cd
48.9	5.3*	"	4.4	65.75	"	5.05	77.5*	"
46.1	7.4	Cd4	5.4	69.3	"	2.7	81.25	"
38.8	13.6	"	5.8	69.8	"	0.95	87.2	"
31.4	20.3	"	7.2	69.9	"	0.4	88.0	"
24.2	27.2	"	8.75	69.6	" + Cd2	0.01	96.5	"
Results at 15°								
46.9	10.1	Cd4	10.6	63.7	Cd4	11.75	68.5	Cd2
35.6	20.7	"	12.3	63.75	"	11.15	70.3	"
20.6	37.0	"	17.5	60.6	" + Cd2	9.35	72.7	"
11.9	50.8	"	16.8	61.4	Cd2	8.65	74.0	"
9.35	59.2	"	16.45	61.8	"	8.70	74.0	" + Cd
9.3	61.7	"	15.3	63.3	"	6.15	77.1	Cd
Results at 20°								
56.05	0.0	Cd4	10.29	60.31	Cd4	26.21	56.13	Cd2
50.05	7.45	"	10.50	62.50	"	27.82	60.01	" + Cd
38.21	18.52	"	12.18	63.72	"	18.53	70.13	Cd
28.47	29.02	"	21.57	59.49	"	12.81	79.07	"
16.57	47.00	"	25.84	52.95	" + Cd2	8.37	85.21	"
15.32	50.18	"	28.31	53.50	Cd2	1.00	96.11	"
Results at 25°								
61.2	0.15	Cd4	18.4	55.5	Cd4	17.5	63.2	Cd2
59.0	2.1	"	18.2	55.9	"	15.0	67.5	"
51.25	9.1	"	28.9	48.5	"	15.1	67.7	" + Cd
41.4	18.6	"	32.45	45.8	"	32.9	49.6*	Cd
25.15	36.8	"	33.9	44.7	"	16.4	65.6*	Cd
21.8	41.45	"	33.8	44.65	" + Cd2	9.3	72.9	"
18.2	47.0	"	30.1	48.6	Cd2	4.05	80.15	"
18.3	47.3	"	29.6	49.2	"	0.95	86.2	"
16.1	52.6	"	24.4	55.0	"	0.08	92.0	"

Results at 35°, 45°, 50°
(See Sieverts and Petzold, 1933e)

* = metastable

Cd9 = $\text{Cd}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$; Cd4 = $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$; Cd2 = $\text{Cd}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$; Cd = $\text{Cd}(\text{NO}_3)_2$.

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THE SYSTEM $\text{Cd}(\text{NO}_3)_2 - \text{Zn}(\text{NO}_3)_2 - \text{H}_2\text{O}$
(Pushin, 1949)

The eutectic in the system $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O} + \text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ contains 27.5 mol % $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and occurs at 28° .

One liter of a saturated solution of $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ in ethyl ether contains 0.6g $\text{Cd}(\text{NO}_3)_2$ at 13° . (Bachelet, Cheylan and Le Bris, 1950)

SOLUBILITY OF CADMIUM NITRATE IN LIQUID AMMONIA
(Donakaja and Portnov, 1939)

NO	t°	Cms. $\text{Cd}(\text{NO}_3)_2$ per 100 gms. NH_3	Solid Phase
-81		6.5	NH_3
-79.5		11.5	"
-77.5		29.5	" + $\text{Cd}(\text{NO}_3)_2 \cdot 4(?)\text{NH}_3$
-75		29.02	" "
-68		24.42	$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{NH}_3$
-56		16.78	"
-47		12.49	"
-33		5.93	"
-29		4.58	"
-25		3.49	"
-21		2.68	"
-9		1.74	"
+ 4		1.01	"
37		0.28	"

Melting point data are given for:

$\text{Cd}(\text{NO}_3)_2 + \text{NH}_4\text{NO}_3$ (1)	$\text{Cd}(\text{NO}_3)_2 + \text{NaNO}_3$ (4)
$\text{Cd}(\text{NO}_3)_2 + \text{NH}_4\text{NO}_3 + \text{NaNO}_3$ (1)	$\text{Cd}(\text{NO}_3)_2 + \text{NaNO}_3 + \text{LiNO}_3$ (4)
$\text{Cd}(\text{NO}_3)_2 + \text{KNO}_3$ (2) (3)	$\text{Cd}(\text{NO}_3)_2 + \text{CsNO}_3$ (5)
$\text{Cd}(\text{NO}_3)_2 + \text{KNO}_3 + \text{RbNO}_3$ (2)	$\text{Cd}(\text{NO}_3)_2 + \text{TlNO}_3$ (5)
$\text{Cd}(\text{NO}_3)_2 + \text{LiNO}_3$ (3)	$\text{Cd}(\text{NO}_3)_2 + \text{CsNO}_3 + \text{TlNO}_3$ (5)
$\text{Cd}(\text{NO}_3)_2 + \text{LiNO}_3 + \text{KNO}_3$ (3)	
(1) Campbell and Campbell, 1947	(4) Protzenko, 1952
(2) Protzenko and Popovskaya, 1953	(5) Protzenko and Rubleva, 1955
(3) Protzenko, 1952a	

O CADMIUM OXIDE CdO OH CADMIUM HYDROXIDE $\text{Cd}(\text{OH})_2$

SOLUBILITY IN WATER

The solubility of cadmium oxide (or hydroxide) in water at 18° was found to be 0.038 millimols (5.0 milligrams) per liter as calculated from electrolytic conductivity, taking into consideration the carbonate content of the H_2O and assuming complete dissociation. The value obtained from the used amount of acid required for saturation, determined conductometrically, was 0.036 millimols (4.80 milligrams) per liter. (Remy, 1925)

The solubility of cadmium hydroxide in water at 25° was determined by conductivity measurements, using one sample of CdO and three samples of Cd(OH)₂. The results in mols. Cd per liter varied from 1.7×10^{-5} to 1.11×10^{-5} . Calculating from 1.15×10^{-5} mols. per liter there is 1.3 mg. Cd per liter. The average of 8 electrolytic determinations (varying from 0.4 to 2.0 mgs. per liter) was 1.0 mg. Cd per liter. These variations were ascribed to the influence of CO₂. (Plater, 1928).

By means of potentiometric measurements Ishikawa and Shiteata, 1932, found 1.4×10^{-5} mol. Cd per liter of solution saturated with Cd(OH)₂ at 25°.

Oka, 1942 found the solubility to be 8.5×10^{-6} moles per liter. Moeller and Rhymer, 1942 found 2×10^{-5} ; the value of Bødlander, 1898 is 1.8×10^{-5} at 25°.

Feitknecht and Reinmann, 1951 found several "active" (more soluble) forms of the hydroxide. The equilibrium phase had a solubility of 1.2×10^{-5} moles per liter. At 18°, Akselrud and Fialkov, 1950 report 1.87×10^{-5} moles per liter.

SOLUBILITY OF CADMIUM HYDROXIDE IN SODIUM HYDROXIDE SOLUTIONS Results of Plater, 1928 at 25°

The average of a long series of determinations made with varying amounts of excess solid, periods of shaking, etc. gave the following values:

Normality of Aq. NaOH	Mols. Cd per liter	Solid Phase
0.0 (= H ₂ O)	1.2×10^{-5}	Cd(OH) ₂
0.01	0.13×10^{-5}	"
0.10	0.13×10^{-5}	"
1.0	0.7×10^{-5}	"
5.0	9.0×10^{-5}	"

Results of Scholder and Staufienbiel, 1941 at the boiling point

The authors determined the composition of the solid phase in equilibrium with solutions of Sodium Hydroxide at the boiling point, 100°, and 80°. Silver vessels were used and the solution was filtered through a sintered glass plate in an atmosphere free of CO₂. The solid was then dried on porous clay plates.

(Cont.)

Cd CADMIUM

Results at the boiling points (120° to 140°)

	Solution			Solution		
	Normality of NaOH	Gms. NaOH per 100 gms. Sat. Sol.	Solid Phase	Normality of NaOH	Gms. NaOH per 100 gms. Sat. Sol.	Solid Phase
OH	3.0	10.4	Cd(OH) ₂	16.1	43.8	Na ₂ Cd(OH) ₄
	6.0	20.0	"	16.6	45.0	"
	9.0	27.5	"	17.1	46.0	"
	12.5	36.0	"	17.3	46.3	"
	13.8	39.2	"	17.6	47.0	"
	14.5	40.5	"	18.0	48.0	"
	15.0	41.5	Na ₂ Cd(OH) ₄	18.4	48.8	"
	15.6	42.8	"	19.0	50.0	"

Results at 100°
(Scholder and Staufenbiel, 1941)

Solution				Solid Phase
Normality of NaOH	Gms. NaOH per 100 gms. Sat. Sol.	Mg. CdO per 100 gms. Sat. Sol.		
6.8	22.7	18.4		Cd(OH) ₂
9.6	30.0	37.7		"
12.1	36.3	65.6		"
13.5	39.4	92.5		"
13.9	40.4	100.7		"
14.8	42.3	89.5		Na ₂ Cd(OH) ₂
16.6	46.3	51.5		"
18.4	50.0	26.5		"

Results at 80°
(Scholder and Staufenbiel, 1941)

At 80° the composition of the solid phases varied with NaOH concentration and were not as clear cut as in the case at the boiling points and 100°.

Final Normality of NaOH N	Approximate Ratios in Solid		Probable Solid Phase
	Cd : Na : H ₂ O		
12.1 - 14.7	1 : 0.3 : 2.8	Cd(OH) ₂	
14.7 - 15.4	1 : 2.1 : 3.5	Na ₂ Cd(OH) ₄	
15.5 - 18.4	1 : 2.6 : 4.3	Na ₂ Cd(OH) ₄ · $\frac{1}{2}$ NaOH · 1-1 $\frac{1}{2}$ H ₂ O	
18.8 - 22.0	1 : 3.3 : 5.3	Na ₃ [Cd(OH) ₅ H ₂ O] · H ₂ O	

SOLUBILITY OF $\text{Cd}(\text{OH})_2$ IN AQUEOUS AMMONIUM HYDROXIDE SOLUTIONSResults at 25°
(Bonsdorff, 1904)Results at 16-21°
(Euler, 1903)

Normality of NH_3	Gms. $\text{Cd}(\text{OH})_2$ per liter	t°	Normality of NH_3	Gms. $\text{Cd}(\text{OH})_2$ per liter
0.5	0.274	16-17	0.47	0.44
1.0	0.707	"	0.87	1.17
1.8	1.516	21	0.26	0.09
4.6	5.609	"	0.51	0.32

5.4% CdO will dissolve in molten cryolite at 1000°. (Hayakawa and Kido, 1952) OH

CADMIUM SULFIDE CdS .

S

Critical reviews of the published solubilities of the metal sulfides in water are given by Kolthoff, 1931, and by Ravitz, 1936. Kolthoff calls attention to the incorrectness of Weigels, 1906, results. He gives a revised list of solubilities and solubility products but made no attempt to correct for activities. Ravitz made a careful study of the results of previous investigators and recalculated them with the aid of recent activity data. His preferred value for cadmium sulfide is:

One liter sat. solution in water contains 1.46×10^{-10} gm. mols. CdS at 25°. The solubility product is 1.14×10^{-28} .

Kapustinsky (1940) calculated the solubility product of CdS from free energy data and obtained the value 1.2×10^{-28} which agrees well with previous values.

The calculated solubility in various solutions are:

pH	3	5	7	9	11
Gm. mols. CdS per liter	1.0×10^{-6}	1.1×10^{-8}	1.5×10^{-10}	1.1×10^{-11}	1.1×10^{-12}

The K_{sp} calculated by Coates, Gordon and Faux (1952) from the free energy data of Rossini (1950) is 7×10^{-27} .

The solid solutions in the system $\text{CdS} - \text{MnS} - \text{ZnS}$ were studied by Kroger (1940) and Kullerud, 1953. Kullerud also gives results for $\text{CdS} + \text{ZnS}$ and $\text{MnS} + \text{FeS} + \text{ZnS} + \text{CdS}$.

CADMIUM SULFATE CdSO_4

SO

SOLUBILITY IN WATER

The most reliable data are probably those of Brickwedde (1946) who found the transition $\text{CdSO}_4 \cdot \frac{5}{2} \text{H}_2\text{O} \rightarrow \text{CdSO}_4 \cdot \text{H}_2\text{O} + \text{aq.}$ to occur at 43.6°. Above 20°, the data of Mylius and Funk (1900) for $\text{CdSO}_4 \cdot \frac{5}{2} \text{H}_2\text{O}$ are in

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excellent agreement; below 20° they are up to 1% higher. The results of Cohen and Walters (1917, 1920) and Steinwehr (1920) [-12 to +25°] are similar (0.1 - 0.2% lower) to those of Brickwedde. Benrath and Thionnessen (1932) give data for the 8/3 hydrate which lie on a not-too-smooth curve about 1% higher than Brickwedde's. Many of the discrepancies can be ascribed to the long time required to reach equilibrium.

The solubility data of Benrath and Thionnessen and of Brickwedde for the monohydrate are identical. The older values of Myliers and Funk are much too high.

In addition, a β form of the monohydrate is reported (B and T), and a heptahydrate (M and F).

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Data of Brickwedde unless noted:

t°	Gms. CdSO ₄ per 100 gms. H ₂ O	Solid Phase	t°	Gms. CdSO ₄ per 100 gms. H ₂ O	Solid Phase
-17	80.2 (1)	CdSO ₄ ·7H ₂ O	34.7	81.5 (3)	CdSO ₄ ·H ₂ O (m).
-10	85.5 (1)	"	40.5	80.2 (3)	" (m)
-5	94.2 (1)	"	45	78.7	"
-10	75.5 (2)	CdSO ₄ · $\frac{8}{3}$ H ₂ O	50	77.1	"
-5	75.5 (2)	"	55	75.5	"
0	75.5 (2)	"	60	73.9	"
	75.75	"	65	72.2	"
5	75.6 (2)	"	70	70.7	"
	75.8	"	74.5	69.5 (3)	CdSO ₄ ·H ₂ O β + CdSO ₄ ·H ₂ O β
10	75.8 (2)	"	75	69.5 (3)	CdSO ₄ ·H ₂ O β
	76.0	"	79	69.5 (3)	"
15	76.1 (2)	"	86.5	64.2 (3)	"
	76.2	"	97	59.2 (3)	"
20	76.4	"	99	58.4 (3)	"
25	76.7	"	112	- (4)	CdSO ₄ ·H ₂ O β + CdSO ₄
30	77.1	"	119	47.5 (4)	CdSO ₄
35	77.6	"	131	36.8 (4)	"
40	78.4	"	159	18.5 (4)	"
43.6	79.0	CdSO ₄ · $\frac{8}{3}$ H ₂ O + CdSO ₄ ·H ₂ O	161	17.4 (4)	"
45	79.4	CdSO ₄ · $\frac{8}{3}$ H ₂ O (m)	166	14.0 (4)	"
50	80.55	" (m)	172	10.9 (4)	"
60	83.7 (1)	" (m)	187	5.2 (4)	"

(m) = metastable

(1) = Mylius and Funk, 1900

(2) = Cohen and Walters, 1917, 1920; Steinwehr, 1920

(3) = Benrath and Thionnessen, 1932

(4) = Benrath, Gjedebø, Schiffers and Wunderlich, 1937

For older work see Kohnstamm and Cohn, 1898; Steinwehr, 1902, Etard, 1894. For data at high pressures see Cohen, 1909. Flöttman, 1928 determined the densities of saturated solutions at 15° (1.6159), 20° (1.6165) and 25° (1.6186).

SOLUBILITY OF CADMIUM SULFATE IN H₂O + D₂O MIXTURES (Brickwedde, 1946)

The author determined the solubility of CdSO₄ in five mixtures of H₂O + D₂O ranging from 0.02% to 99.5% D₂O and at temperatures from -1° to 72°. The results were plotted, and the author presents the table below which lists values at temperatures and D₂O concentrations found mainly by interpolation. The transition CdSO₄·8/3H₂O \rightleftharpoons CdSO₄·H₂O + Aq. occurred at 43.6°, and CdSO₄·8/3D₂O \rightleftharpoons CdSO₄·D₂O + aq. at 45.4°. The

results agree rather well with those previously reported (see above), and a composite graph is drawn. Many previous authors did not realize that their data were metastable because of the long time required to attain equilibrium.

MOLES CdSO_4 PER 100 MOLES OF SOLVENT

Solid Phase	t°	Mole % D_2O in Solvent					
		0.02†	6.0	50.0	80.0	99.5	100.0
$\text{CdSO}_4 \cdot \frac{8}{3}\text{Aq.}$	0	6.546	6.511	6.285	6.131	6.029	6.026
"	5	6.555	6.520	6.294	6.138	6.036	6.033
"	10	6.566	6.531	6.305	6.147	6.045	6.042
"	15	6.580	6.545	6.319	6.159	6.058	6.055
"	20	6.600	6.565	6.339	6.177	6.076	6.073
"	23.5	6.619	6.584	6.358	6.194	6.093	6.090
"	25	6.627	6.592	6.366	6.202	6.100	6.097
"	30	6.663	6.627	6.402	6.236	6.133	6.130
"	35	6.710	6.674	6.449	6.281	6.177	6.174
"	40	6.773	6.737	6.512	6.342	6.235	6.232
"	42	6.803	6.769	6.542	6.371	6.263	6.260
"	45	6.857*	6.823	6.594	6.423	6.314	6.311
"	50	6.966*	6.932*	6.696*	6.530*	6.418*	6.415*
$\text{CdSO}_4 \cdot \frac{8}{3}\text{Aq.} + \text{CdSO}_4 \cdot 1\text{Aq.}$	43.6	6.833	-	-	-	-	-
"	43.9	-	6.803	-	-	-	-
"	45.0	-	-	6.592	-	-	-
"	45.3	-	-	-	6.430	-	-
"	45.4	-	-	-	-	6.317	6.314
$\text{CdSO}_4 \cdot \text{Aq.}$	45	6.797	6.775	6.591*	6.440*	6.330*	6.326*
"	50	6.659	6.638	6.448	6.299	6.185	6.181
"	55	6.522	6.501	6.304	6.159	6.041	6.037
"	60	6.385	6.363	6.159	6.019	5.897	5.893
"	65	6.24	-	-	-	-	-
"	70	6.11	-	-	-	-	-
"	72	6.05	-	-	-	-	-

SO

† 0.02% D_2O = Ordinary Water

* = Metastable

SOLUBILITY OF CADMIUM SULPHATE IN AQUEOUS SOLUTIONS OF SULPHURIC ACID AT 0°
(Engel, 1887)

Equivalents per 10 Gms. H_2O		Density of Solutions	Grams per 100 Grams H_2O	
H_2SO_4	CdSO_4		H_2SO_4	CdSO_4
0.	71.6	1.609	0.00	74.61
3.87	70.9	1.591	1.90	73.87
12.6	62.4	1.545	6.18	65.03
28.1	50.6	1.476	13.78	52.73
43.3	40.8	1.435	21.23	42.52
47.6	37.0	1.421	23.34	38.56
53.8	32.7	1.407	26.38	34.07
71.5	23.0	1.379	35.06	23.96

Additional data for this system at 0°, 16°, 21° and 35.5° are given by Arditti, 1933, but the results are presented only in the form of diagrams.

Cd CADMIUM

SOLUBILITY OF CADMIUM SULFATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°

Gms. per 100 gms. aq. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CH ₃ COOH	CdSO ₄		CH ₃ COOH	CdSO ₄	
9.78	31.72	CdSO ₄ · ⁸ / ₃ H ₂ O	71.34	0.11	CdSO ₄ · ⁸ / ₃ H ₂ O
20.85	19.87	"	76.35	0.05	"
32.39	10.05	"	85.49	0.02	CdSO ₄ ·H ₂ O
46.23	2.77	"	95.79	0.015	"

Several determinations at 30° gave results practically identical with the above.

SOLUBILITY OF CADMIUM SULFATE IN AMMONIA SOLUTIONS AT 25°
(Urazov and Kirakosyan, 1953)

The solutions contained a relatively constant amount of (NH₄)₂SO₄. The solid phase is probably a solid solution. See also below.

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
NH ₃	(NH ₄) ₂ SO ₄	CdSO ₄		NH ₃	(NH ₄) ₂ SO ₄	CdSO ₄	
0.885	5.37	7.38	1:1:x	6.60	3.05	32.54	2:2:1:0
1.23	3.31	6.75	1:2:x	7.41	2.74	35.12	2:2:1:0
1.29	3.78	8.27	1:2:x	7.91	2.48	33.90	2:2:3:x
1.50	3.97	9.85	3:2:2:0	9.42	2.54	42.25	5:6:2:1
2.54	3.80	13.80	4:1:9:x	11.52	2.34	47.50	2:2:1:x
2.82	3.54	16.64	2:2:1:0	12.48	2.23	48.54	-
4.10	3.28	21.85	4:3:6:x				

1:1:x = CdSO₄·Cd(OH)₂·xH₂O; 1:2:x = CdSO₄·Cd(OH)₂·xH₂O; 3:2:2 = 3CdSO₄·2NH₃·2Cd(OH)₂; 4:1:9:x = 4CdSO₄·NH₃·9Cd(OH)₂·xH₂O; 2:2:1:0 = 2CdSO₄·2NH₃·Cd(OH)₂; 4:3:6:x = 4CdSO₄·3NH₃·6Cd(OH)₂·xH₂O; 2:2:3:x = 2CdSO₄·2NH₃·3Cd(OH)₂·xH₂O; 5:6:2:1 = 5CdSO₄·6NH₃·2Cd(OH)₂·H₂O; 2:2:1:x = 2CdSO₄·2NH₃·Cd(OH)₂·xH₂O.

30 BASIC CADMIUM SULFATES

THE SYSTEM CADMIUM SULFATE - CADMIUM HYDROXIDE - WATER AT 25°
(Urazov and Kirakosyan, 1954)

The authors studied the system using freshly precipitated and air-dried Cd(OH)₂ and found two double salts: CdSO₄·Cd(OH)₂ and CdSO₄·2Cd(OH)₂. (With air-dried material the former salt had a composition near to 5 CdSO₄·6Cd(OH)₂). The transition from 1:2 to 1:1 occurs in a solution containing about 1% CdSO₄. At very low concentrations CdSO₄·3Cd(OH)₂ forms.

EQUILIBRIUM IN THE SYSTEM CADMIUM OXIDE - CADMIUM SULFATE - WATER AT 18°
(Gromov, 1948)

CdSO ₄ Wt. %	Cd Gms. per Liter	Density	pH	Solid Phase	
43.4	368.6	1.580	5.65	3CdO·CdSO ₄ ·xH ₂ O + CdSO ₄ · $\frac{8}{3}$ H ₂ O	
25.6	178.2	1.292	6.31	3CdO·CdSO ₄ ·xH ₂ O	
16.9	109.3	1.176	6.70	"	
10.9	64.8	1.097	7.00	"	
6.88	38.7	1.042	7.19	"	
2.35	12.8	1.010	7.38	"	
2.17	11.8	1.009	7.38	"	
0.00	0.0	1.000	8.00	Cd(OH) ₂	30

In contrast to the above results. Bye (1945) presents evidence that the compound Cd(OH)₂·CdSO₄ exists in equilibrium with solutions containing 0.3% to 43.6% CdSO₄, and that the compound 3Cd(OH)₂·CdSO₄ exists only in contact with solutions containing 0.1% to 0.2% CdSO₄.

Denk, 1949 studied the precipitation of Cadmium Sulfate upon addition of Sodium Hydroxide and Sodium Carbonate at various temperatures, and concluded that 3 basic salts exist: CdSO₄·3Cd(OH)₂, CdSO₄·2Cd(OH)₂, CdSO₄·Cd(OH)₂.

THE SYSTEM CADMIUM SULFATE - COBALT SULFATE - WATER
(Bassett and Sanderson, 1934)

It was found that 80° CdSO₄· $\frac{8}{3}$ H₂O forms solid solutions with the corresponding cobalt compound. It was also found that the α and β forms of cadmium sulfate monohydrate give rise to two independent sets of solid solutions containing cobalt sulfate monohydrate--All the solid phases are solid solutions, although the amount of cobalt sulfate in the CdSO₄· $\frac{8}{3}$ H₂O phase at 25° is very small.

Results at 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoSO ₄	CdSO ₄		CoSO ₄	CdSO ₄		CoSO ₄	CdSO ₄	
27.05	0.0	A	12.35	31.02	B	5.05	34.84	D
22.38	9.97	B	11.55	32.64	C	3.43	40.46	"
18.89	17.78	"	9.44	34.52	D	1.78	41.84	"
15.62	23.90	"	8.00	35.85	"	0.0	43.83	E
13.42	28.88	"						

A = CoSO₄·7H₂O; B = Solid Solution of CoSO₄·7H₂O and CdSO₄·7H₂O;
C = Solid Solution of B and CdSO₄· $\frac{8}{3}$ H₂O (Solid Solution); D = CdSO₄· $\frac{8}{3}$ H₂O
(Solid Solutions) E = CdSO₄· $\frac{8}{3}$ H₂O.

(Cont.)

Cd CADMIUM

Results at 80°

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoSO ₄	CdSO ₄		CoSO ₄	CdSO ₄		CoSO ₄	CdSO ₄	
SO	39.94	-	F	28.25	19.30*	III	4.66	39.33*	III
	36.60	5.94	I	25.59	20.83	"	3.63	40.40*	"
	34.30	9.91	"	24.63	21.24	"	18.32	28.25*	IV
	31.67	15.35*	"	23.32	21.85	"	16.74	29.15*	"
	32.01	14.08	" + II	22.06	22.83	"	12.53	31.45*	"
	29.46	18.96*	" + III	18.12	26.08	"	7.20	34.98	"
	29.66	16.63	II	15.56	27.94	"	3.00	38.11	"
	28.77	17.30	"	14.13	29.37	"	0.0	40.31	G
	28.32	17.83	"	8.31	34.95*	"	0.0	45.80	H
	26.90	19.31	"						

* = metastable

F = CoSO₄·4H₂O; G = β CdSO₄·H₂O; H = α CdSO₄·H₂O; I = Solid solution of CdSO₄·4H₂O and CoSO₄·4H₂O; II = solid solution of CdSO₄·H₂O and CoSO₄·H₂O; III = solid solution of CdSO₄·H₂O and CoSO₄·H₂O; IV = solid solution of β CdSO₄·H₂O and β CoSO₄·H₂O.

The above solid solutions and also the solid solutions of CdSO₄·7H₂O and CoSO₄·7H₂O are red.

SOLUBILITY OF MIXED CRYSTALS OF CADMIUM SULPHATE AND FERROUS
SULPHATE IN WATER AT 25°
(Stortenbecker, 1900)

Composition of Solution					Mol. per cent Cd in Crystals of Solid Phase
Gms. per 100 Gms. H ₂ O		Mols. per 100 Mols. H ₂ O		Mol. % Cd. in Sol.	
CdSO ₄	FeSO ₄	Cd	Fe		
Crystals with 2½ Mols. H ₂ O.					
76.02	0.0	6.57	0.0	100	100
57.61	10.63	4.98	1.26	79.8	99.0
Crystals with 7 Mols. H ₂ O.					
57.61	10.63	4.98	1.26	79.8	36.6
...	...	...	...	78.5	34.6
...	...	...	...	44.6	11.1
...	...	...	...	24.4	4.8
0.0	26.69	0.0	3.165	0.0	0.0

THE SYSTEM CADMIUM SULFATE - POTASSIUM SULFATE - WATER
(Benrath and Thionnessen, 1932)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CdSO_4		K_2SO_4		CdSO_4		K_2SO_4	
Results at 0°				Results at 60°			
42.78	2.27		$\text{Cd}\frac{8}{3} + \text{D}$	42.65	1.90		$\text{CdI}\alpha + \text{E}$
41.04	3.17		D	37.93	4.12		E
39.23	4.22		"	33.80	6.42		"
39.08	4.52		" + B	31.51	8.07		" + D + F
30.15	6.42		B	30.38	9.07		F
27.38	7.20		"	29.50	9.39		" + C
20.61	9.04		" + K				
15.48	8.60		K				
Results at 13.3°							
41.86	2.48		$\text{Cd}\frac{8}{3} + \text{D}$	30.20	9.2		E + F
41.52	2.68		D				
36.93	5.61		" + B + C				
35.58	6.05		B				
31.80	7.07		"				
21.18	10.64		" + K				
15.69	10.39		K				
6.69	9.89		"				
Results at 25°							
43.4	2.08		$\text{Cd}\frac{8}{3} + \text{D}$	40.88	2.24		$\text{CdI}\beta + \text{E}$
39.38	3.58		D	35.13	4.05		E
35.22	6.38		" + C	25.68	10.45		"
30.62	7.97		C	26.15	10.3		" + F
26.11	9.52		"	23.1	11.65		F
22.03	11.12		"	21.79	12.39		" + C
20.52	11.90		" + K	17.32	14.37		C
16.35	11.90		K	14.17	15.93		"
				11.69	17.54		" + K
				6.76	17.06		K
Results at 50°							
43.58	20.7		$\text{CdI}\alpha + \text{E}$	39.42	2.38		$\text{CdI}\beta + \text{E}$
41.10	2.83		E	32.04	4.44		E
40.43	3.14		" + D	25.71	7.68		"
35.33	5.78		D	20.61	12.83		" + F
31.70	8.52		" + C	17.24	14.78		F
29.20	9.22		C	15.91	15.79		" + C
23.70	11.19		"	13.37	16.43		C
17.35	13.77		"	10.45	19.45		" + K
15.14	14.88		" + K	6.0	19.42		K
3.20	14.33		K				
Results at 99°							
43.58	20.7		$\text{CdI}\alpha + \text{E}$	37.58	2.54		$\text{CdI}\beta + \text{E}$
41.10	2.83		E	32.31	3.69		E
40.43	3.14		" + D	28.73	4.95		"
35.33	5.78		D	22.42	7.77		"
31.70	8.52		" + C	20.13	10.58		"
29.20	9.22		C	17.38	13.74		" + F
23.70	11.19		"	16.36	14.36		F
17.35	13.77		"	13.17	17.53		" + C
15.14	14.88		" + K	10.78	19.29		C
3.20	14.33		K	9.5	20.23		" + K
				5.29	19.93		K

$\text{Cd}\frac{8}{3} = \text{CdSO}_4 \cdot \frac{8}{3}\text{H}_2\text{O}$; $\text{CdI} = \text{CdSO}_4 \cdot \text{H}_2\text{O}$; $\text{B} = \text{CdSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$;
 $\text{C} = \text{CdSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 1\frac{1}{2}\text{H}_2\text{O}$; $\text{D} = 3 \text{CdSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 5\text{H}_2\text{O}$; $\text{E} = 3\text{CdSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$;
 $\text{F} = 3\text{CdSO}_4 \cdot 2\text{K}_2\text{SO}_4 \cdot \text{H}_2\text{O}$; $\text{K} = \text{K}_2\text{SO}_4$

Cd CADMIUM

THE SYSTEM $\text{CdSO}_4 - \text{K}_2\text{SO}_4 - \text{H}_2\text{O}$ (Cont.)
 Data of Malhotra and Suri, 1930 at 25°
 (considerably less complex than those above)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CdSO_4	K_2SO_4		CdSO_4	K_2SO_4	
	43.53	0.0	$\text{CdSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$	24.91	11.18	$\text{CdSO}_4 \cdot \text{K}_2\text{SO}_4$
	43.71	0.55	"	24.19	11.91	" + K_2SO_4
	43.21	1.85	"	18.95	11.90	K_2SO_4
	43.05	3.15	" + $\text{CdSO}_4 \cdot \text{K}_2\text{SO}_4$	15.73	11.62	"
30	39.22	4.33	$\text{CdSO}_4 \cdot \text{K}_2\text{SO}_4$	12.55	11.40	"
	35.83	5.46	"	10.62	11.39	"
	33.81	6.14	"	6.60	11.50	"
	31.24	7.20	"	4.58	11.13	"
	29.00	8.48	"	2.66	10.77	"
	27.02	10.05	"	0.0	10.77	"

SOLUBILITY OF CADMIUM POTASSIUM SULFATE IN WATER
 (Wyrouboff, 1901)

t°	G. $\text{CdK}_2(\text{SO}_4)_2$ per 100 Gms. H_2O		Solid Phase	t°	G. $\text{CdK}_2(\text{SO}_4)_2$ per 100 Gms. H_2O		Solid Phase
16	42.89		$\text{CdK}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$	26	42.50		$\text{CdK}_2(\text{SO}_4)_2 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
31	46.82		"	31	42.80		"
40	47.40		"	40	43.45		"
				64	44.90		"

THE SYSTEM CADMIUM SULFATE - LITHIUM SULFATE - WATER AT 30°
 (Parks, Patterson and Vosburgh, 1937)

	Gms. per 100 gms. sat. sol.		Solid Phase		Gms. per 100 gms. sat. sol.		Solid Phase
	CdSO_4	Li_2SO_4			CdSO_4	Li_2SO_4	
	42.5	0.9	$\text{CdSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$		26.0	13.9	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
	40.0	2.9	"		15.7	17.8	"
	36.7	6.6	"		9.7	20.3	"
	29.6	12.5	" + $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$		2.9	23.2	"

THE SYSTEM CADMIUM SULFATE - MANGANESE SULFATE - WATER
 AT SEVERAL TEMPERATURES
 (Benrath and Thiemann, 1936)

The determinations were made for the purpose of gaining information in regard to the nature of the other form into which cadmium sulfate monohydrate changes at 75°. If this is a monomeric Kieserite there should be a gap in the mixed crystals formed with MnSO_4 below 75° and none above that temperature. From the several series of determinations the following values for the two salt points and border concentrations of mixed crystal series were obtained.

t°	Two salt pairs		Border concs. of Cd mixed cryst. series		Border concs. of Mn mixed cryst. series	
	x	m	x	m	x	m
53	53.0*	12.2	40.0	1.0	64.0	1.0
68	53.0	13.2	41.0	1.0	64.5	1.0
75	54.5	13.6	41.5	1.0	65.0	1.0
99	65.0	15.1	53.0	1.0	77.0	1.0

THE SYSTEM CADMIUM SULFATE - MAGNESIUM SULFATE - WATER AT 25° AND 40°
(Vosburg, Dibeler, Parks, and Miller, 1940)

30

The authors determined dE/dT for a cell saturated with $MgSO_4 \cdot 7H_2O$ and $CdSO_4 \cdot \frac{8}{3}H_2O$ and found an abrupt change about 30°. Equimolecular quantities of the two salts were equilibrated with water at 40°, and the cooling curve was determined. Heat was liberated at 30.2° and so the transition temperature for the double salt in contact with an equimolecular mixture of $MgSO_4$ and $CdSO_4$ was 30.2°. Many determinations were made at 25° ($\pm 0.1^\circ$) to try to detect the field of stability for the double salt, but none was found. At 40° ($\pm 0.2^\circ$) the compound is congruently soluble.

Results at 25°

Gme. $CdSO_4$ per 100 gms.	Gms. $MgSO_4$ per 100 gms.	Solid Phase
6.5	23.8	$MgSO_4 \cdot 7H_2O$
12.5	20.9	"
17.2	18.3	"
17.4	18.9	"
21.7	17.0	"
25.5	15.2	$MgSO_4 \cdot 7H_2O + CdSO_4 \cdot \frac{8}{3}H_2O$
25.7	14.9	"
25.8	15.4	"
26.0	15.0	"
26.1	15.0	"
26.2	15.3	"
26.2	15.1	"
26.4	15.0	"
26.4	15.2	"
26.9	14.9	"
27.0	13.9	$CdSO_4 \cdot \frac{8}{3}H_2O$
29.1	12.5	"
30.5	11.2	"
30.5	11.0	"
34.0	8.0	"
38.6	4.3	"

Cd CADMIUM

Results at 40°		
Gms. CdSO ₄ per 100 gms.	Gms. MgSO ₄ per 100 gms.	Solid Phase
2.6	29.6	MgSO ₄ ·7H ₂ O
5.0	28.8	"
7.6	27.8	"
9.2	28.0	MgSO ₄ ·7H ₂ O + 1:1:14
9.6	27.8	"
10.2	27.5	"
9.6	28.3	"
12.1	24.4	1:1:14
17.2	20.0	"
14.5	22.4	"
20.0	17.6	"
20.9	17.1	"
24.2	14.3	"
28.2	12.2	"
33.5	10.4	"
38.8	9.2	"
39.6	9.2	1:1:4 + CdSO ₄ · $\frac{8}{3}$ H ₂ O
40.1	8.8	"
40.9	7.7	CdSO ₄ · $\frac{8}{3}$ H ₂ O
42.7	4.5	"

THE SYSTEM CADMIUM SULFATE - AMMONIUM SULFATE - WATER
 (Benrath and Thiemann, 1932)
 (Malhotra and Suri, 1930 (25° only))
 (see also below)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdSO ₄	(NH ₄) ₂ SO ₄		CdSO ₄	(NH ₄) ₂ SO ₄	
Results at 0°			Results at 25°--Contd.		
2.56	39.60	N + Sch	41.84	7.32	Cd ₃ ⁸ + Sch
3.73	34.45	Sch	37.98	8.82	Sch
6.63	26.75	"	36.04	9.28	"
10.97	18.86	"	32.15	11.80	"
19.84	11.77	"	28.78	13.90	"
25.28	9.18	"	25.25	16.72	"
32.59	6.34	"	16.75	24.24	"
38.91	4.83	"	15.38	26.29	"
40.68	4.47	" + Cd ₃ ⁸	11.04	33.03	"
Results at 25° (M and S)		%	7.93	38.50	"
			7.55	39.68	" + N
			6.95	39.90	N
43.5	0.0	Cd ₃ ⁸	4.99	40.75	"
42.63	3.44	"	2.42	42.01	"
42.30	6.72	"	0.0	43.40	"

N = (NH₄)₂SO₄; Cd $\frac{8}{3}$ = CdSO₄· $\frac{8}{3}$ H₂O; Cd1 = CdSO₄·H₂O;
 Sch = CdSO₄·(NH₄)₂SO₄·6H₂O; C = CdSO₄·(NH₄)₂SO₄·2H₂O;
 D = 3CdSO₄·(NH₄)₂SO₄·5H₂O; L = 2CdSO₄·(NH₄)₂SO₄

The densities of the saturated solutions are also given.

THE SYSTEM CADMIUM SULFATE - AMMONIUM SULFATE - WATER--Contd.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CdSO ₄	(NH ₄) ₂ SO ₄	Solid Phase	CdSO ₄	(NH ₄) ₂ SO ₄	Solid Phase
Results at 44.9°			Results at 62.4°		
32.50	19.70	D + Sch	15.82	39.42	N + L
41.83	8.12	" + CdI	36.25	13.20	L
42.13	8.10	" "	39.05	10.88	"
			40.11	10.03	" + CdI
Results at 45.5°			Results at 77.1°		
16.82	37.21	N + Sch			
31.87	20.34	D			
33.84	17.80	"	0.0	47.43	N
Results at 50°			5.42	45.63	"
4.69	42.79	N	11.39	42.81	N
10.87	39.98	"	12.88	42.12	" + L
15.38	37.97	"	12.37	42.17	L
17.09	37.20	" + C	13.50	40.78	"
19.10	35.01	C	14.68	38.86	"
21.27	32.44	"	17.37	33.64	"
23.05	30.52	"	19.20	30.89	"
25.98	27.21	" + L	22.41	26.40	"
28.46	23.51	L	25.44	22.31	"
31.00	21.87	D	29.45	17.83	"
32.69	19.20	" + L	34.20	13.72	"
32.20	19.30	"	39.14	9.95	" + CdI
32.84	19.19	"	39.31	8.43	CdI
36.24	14.41	"	40.13	3.38	"
39.06	11.25	"			
42.06	8.10	" + CdI	Results at 97°		
42.18	5.17	CdI			
43.64	0.0	"	0.0	50.11	N
Results at 55.5°			4.67	47.95	"
35.61	14.03	L + D	9.80	45.60	" + L
41.13	9.03	CdI + D	10.83	42.59	L
Results at 61.9°			14.90	33.32	"
15.89	39.31	N + L	17.76	28.22	"
18.97	33.85	L	23.34	20.49	"
20.19	32.14	"	30.93	13.19	"
40.09	10.13	" + CdI	37.31	8.13	CdI
			41.52	6.47	L
			35.79	4.35	CdI

N = (NH₄)₂SO₄; Cd₂ = CdSO₄ · $\frac{8}{3}$ H₂O; CdI = -CdSO₄ · H₂O;
 Sch = CdSO₄ · (NH₄)₂SO₄ · 6H₂O; C = CdSO₄ · (NH₄)₂SO₄ · 2H₂O;
 D = 3CdSO₄ · (NH₄)₂SO₄ · 5H₂O; L = 2CdSO₄ · (NH₄)₂SO₄

The densities of the saturated solutions are also given.

Cd CADMIUM

THE SYSTEM $\text{CdSO}_4 + 2\text{NH}_4\text{OH} \rightleftharpoons \text{Cd}(\text{OH})_2 + (\text{NH}_4)_2\text{SO}_4 + (\text{H}_2\text{O})$ at 25°
(Urazov and Kirsosyan, 1953a)

Gms. per 100 gms. sat. sol.			Solid Phase
CdSO_4	$(\text{NH}_4)_2\text{SO}_4$	NH_4OH	
43.45	0.0	0.0	$\text{CdSO}_4 \cdot \frac{8}{3}\text{H}_2\text{O}$
0.0	43.40	0.0	$(\text{NH}_4)_2\text{SO}_4$
0.0	0.0	62.85	"
0.0	0.0	(.0025)*	$\text{Cd}(\text{OH})_2 \cdot x\text{H}_2\text{O}$
42.32	4.65	0.06	$\frac{8}{3} + \text{hydroxide}$
40.85	5.67	0.10	" "
30 41.84	7.32	0.0	$\frac{8}{3} + 1:1:6$
42.08	8.15	0.13	$\frac{8}{3} + 1:1:6 + \text{hydroxide}$
33.05	12.64	0.21	1:1:6 + hydroxide
25.34	16.08	0.0	1:1:6
21.75	21.68	0.32	1:1:6 + hydroxide
16.20	26.30	0.38	" "
7.55	39.68	0.0	1:1:6 + $(\text{NH}_4)_2\text{SO}_4$
13.15	28.65	0.52	" + " + hydroxide
15.36	31.43	2.45	$(\text{NH}_4)_2\text{SO}_4 + \text{hydroxide}$
18.54	29.52	6.82	" "
23.82	23.00	12.84	" "
24.27	22.48	14.25	" "
25.10	22.10	16.60	" + " + D
35.08	13.20	25.52	D + hydroxide
37.20	9.30	28.00	D + E + hydroxide
42.64	4.56	30.52	D + hydroxide
39.25	(2.87)*	31.75	" "
26.06	(3.30)*	39.60	" "
24.65	(2.92)*	41.00	" "
4.55	(2.81)*	55.0	" "
0.0	(1.86)*	58.64	$\text{Cd}(\text{OH})_2$
0.0	6.74	60.36	$(\text{NH}_4)_2\text{SO}_4$
2.25	0.0	59.5	D
14.05	3.75	47.6	D + E
24.53	6.54	37.0	" "
31.74	8.63	31.23	" "
36.5	8.5	30.48	" "
25.83	22.72	28.32	$(\text{NH}_4)_2\text{SO}_4 + \text{E}$
21.63	21.52	30.56	" "
12.40	12.75	37.06	" "
9.23	10.40	40.04	" "
3.38	4.12	58.2	" "
3.12	1.92	60.25	E

* = % $\text{Cd}(\text{OH})_2$

$\frac{8}{3}$ = $\text{CdSO}_4 \cdot \frac{8}{3}\text{H}_2\text{O}$

hydroxide = $\text{Cd}(\text{OH})_2 \cdot x\text{H}_2\text{O}$

1:1:6 = $\text{CdSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$

D = $[\text{Cd}(\text{NH}_3)_4(\text{H}_2\text{O})_2] \text{SO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$

E = $[\text{Cd}(\text{NH}_3)_5\text{H}_2\text{O}] \text{SO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$

THE SYSTEM CADMIUM SULFATE - SODIUM SULFATE - WATER
(Benrath and Thiemann, 1932 (50° to 90°); Benrath and Benrath, 1929 (97°);
Koppel-Gumpert, 1905 (-14° to 40))

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CdSO ₄	Na ₂ SO ₄	Solid Phase	CdSO ₄	Na ₂ SO ₄	Solid Phase
Results at -14°			Results at 50°		
40.18	4.60	Cd ₃ ^s + L	4.25	29.94	Na
			7.82	28.67	"
Results at 0°			9.10	28.67	" + N
			10.46	26.92	N
40.32	4.85	Cd ₃ ^s + L	12.96	25.11	" + L
37.30	6.53	L + Na 10	14.54	23.60	L
Results at 10°			18.46	20.26	"
			28.72	13.15	"
39.91	5.24	Cd ₃ ^s + L	32.74	10.83	"
32.53	8.69	L + Na 10	39.36	7.63	" + Cdl
			41.39	3.27	Cdl
Results at 20°			44.58	0.0	" + Cd ₃ ^s
			Results at 59°		
40.26	5.16	Cd ₃ ^s + L	8.52	28.07	Na + N
22.69	14.71	L + Na 10	12.35	24.77	N
Results at 24°			17.21	21.78	" + L
			20.06	19.10	L
22.25	15.07	L	32.32	11.50	"
Results at 25°			Results at 65°		
			4.33	29.26	Na
16.33	19.82	L + Na 10	8.06	28.09	" + N
Results at 30°			11.35	25.34	N
			15.02	22.84	" + G
22.55	15.29	L	20.69	18.84	G
9.21	27.80	L + Na	26.36	14.96	"
Results at 35°			36.78	9.63	" + Cdl
			38.04	7.00	Cdl
			39.94	3.28	"
8.26	29.35	L + Na	42.10	0.0	"
Results at 40°			Results at 70°		
			6.94	28.33	Na + V
22.89	15.65	L	8.42	27.26	N + V
39.89	7.18	L + Cd ₃ ^s	12.04	24.53	N
9.98	28.27	L + Na -	15.73	22.13	N + G
			15.73	21.80	G

Na = Na₂SO₄; Cd₃^s = CdSO₄· $\frac{2}{3}$ H₂O; Cdl = CdSO₄·H₂O; G = CdSO₄·Na₂SO₄;
L = CdSO₄·Na₂SO₄·2H₂O; N = CdSO₄·2Na₂SO₄; V = CdSO₄·3Na₂SO₄;
Na 10 = Na₂SO₄·10H₂O

The densities of the sat. solutions are also given.

(Cont.)

Cd CADMIUM

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CdSO ₄	Na ₂ SO ₄			CdSO ₄	Na ₂ SO ₄		
Results at 75°				Results at 97°			
5.55	28.70	Na + V		0.0	30.50	Na	
6.55	27.75	V		2.24	28.59	"	
9.48	26.33	V + N		2.92	28.98	" + V	
11.94	24.62	N		3.87	27.82	V	
Results at 80°				6.04	25.29	"	
1.69	29.76	Na		8.24	24.14	"	
4.23	29.11	" + V		10.91	22.60	V + G	
6.48	27.23	V		11.20	22.26	" "	
9.53	24.87	"		12.98	20.02	G	
12.12	23.58	" + G		13.90	18.89	"	
15.87	20.39	G		18.90	15.78	"	
18.72	18.15	G		23.90	13.02	"	
25.20	14.23	"		27.33	11.84	"	
35.96	9.39	" + Cdl		34.97	9.44	G + Cdl	
38.75	1.88	Cdl		35.50	7.42	Cdl	
Results at 90°				36.32	5.32	"	
3.63	28.96	Na + V		36.85	2.40	"	
11.24	22.99	V + G		37.23	0.0	"	

Na = Na₂SO₄; Cd₃ = CdSO₄· $\frac{2}{3}$ H₂O; Cdl = CdSO₄·H₂O; G = CdSO₄·Na₂SO₄;
 L = CdSO₄·Na₂SO₄·2H₂O; N = CdSO₄·2Na₂SO₄; V = CdSO₄·3Na₂SO₄;
 Na 10 = Na₂SO₄·10H₂O

The densities of the sat. solutions are also given.

THE SYSTEM CADMIUM SULFATE - RUBIDIUM SULFATE - WATER
(Benrath and Thionnessen, 1932)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CdSO ₄	Rb ₂ SO ₄			CdSO ₄	Rb ₂ SO ₄		
Results at 0°				Results at 25°			
41.92	3.90	Cd ₃ + D		42.27	3.51	Cd ₃ + D	
39.39	4.8	D		42.14	3.6	D	
36.88	6.25	D + Sch		38.75	5.1	"	
27.51	8.09	Sch		32.7	9.27	"	
18.34	16.0	"		28.41	14.29	"	
10.86	12.78	"		26.81	16.9	" + Sch	
6.22	16.97	"		14.89	24.56	Sch	
4.91	19.2	" + Rb		9.18	30.66	"	
				6.7	32.75	" + Rb	
				4.39	34.39	Rb	

Cd₃ = CdSO₄· $\frac{2}{3}$ H₂O; D = 3CdSO₄·Rb₂SO₄·5H₂O; Sch = CdSO₄·Rb₂SO₄·6H₂O;
 C = CdSO₄·Rb₂SO₄·2H₂O; L = 2CdSO₄·Rb₂SO₄; Cdl = CdSO₄·H₂O.

(Cont.)

CADMIUM Cd

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdSO ₄	Rb ₂ SO ₄		CdSO ₄	Rb ₂ SO ₄	
Results at 50°			Results at 75°		
43.48	2.89	Cdl + D	40.4	4.38	Cdl β + D
39.05	4.9	D	39.75	4.7	D
36.32	5.86	"	31.06	9.49	"
29.9	11.83	"	27.81	11.34	" + L
23.31	18.09	"	22.17	15.35	L
22.68	20.17	"	13.93	24.4	"
19.65	25.23	" + C	13.93	24.4	"
16.51	27.61	C	10.0	30.61	"
14.8	29.1	"	8.35	38.3	"
13.12	31.1	"	7.61	40.89	" + Rb
8.82	35.93	"			
7.92	37.54	" + Rb			
					Results at 97.5°

Results at 62°					
22.32	19.0	D	37.8	6.25	Cdl β + L
19.9	24.1	" + L	38.15	5.53	L
17.47	24.85	L	30.28	8.96	"
15.3	30.03	" + C	14.74	14.89	"
10.19	35.79	C	9.38	26.5	"
8.94	38.26	" + Hb	5.43	38.82	"
			2.27	46.25	"

$Cd\beta = CdSO_4 \cdot \frac{2}{3}H_2O$; $D = 3CdSO_4 \cdot Rb_2SO_4 \cdot 5H_2O$; $Sch = CdSO_4 \cdot Rb_2SO_4 \cdot 6H_2O$;
 $C = CdSO_4 \cdot Rb_2SO_4 \cdot 2H_2O$; $L = 2CdSO_4 \cdot Rb_2SO_4$; $Cdl = CdSO_4 \cdot H_2O$.

THE SYSTEM CADMIUM SULFATE - THALLOUS SULFATE - WATER
 (Benrath and Thionnesen, 1932)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CdSO ₄	Tl ₂ SO ₄		CdSO ₄	Tl ₂ SO ₄	
Results at 0°			Results at 25°--Contd.		
41.90	3.4	Cd ₂ + D	31.12	12.95	Cd ₂ + Tl
39.48	5.21	D	6.81	7.21	Tl
39.07	6.5	" + Tl			
32.04	8.13	Tl			
Results at 25°			Results at 50°		
			43.32	4.81	Cdl + D
			37.95	6.97	D
			38.12	7.38	"
42.75	1.8	Cd ₂	36.0	8.1	"
42.0	3.6	" + D	32.07	12.03	"
39.43	4.95	D	28.93	16.77	" + Tl
35.03	8.55	"	12.18	12.88	Tl

$Cd\beta = CdSO_4 \cdot \frac{2}{3}H_2O$; $D = 3CdSO_4 \cdot Tl_2SO_4 \cdot 5H_2O$; $L = 2CdSO_4 \cdot Tl_2SO_4$;
 $Tl = Tl_2SO_4$; $Cdl = CdSO_4 \cdot H_2O$.

(Cont.)

Cd CADMIUM

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CdSO ₄	Tl ₂ SO ₄			CdSO ₄	Tl ₂ SO ₄		
Results at 75°				Results at 97°			
37.25	7.9	CdI β + D		36.85	5.2	CdI β	
36.65	8.83	D		36.25	7.33	" + L	
32.78	12.7	" + L		34.51	8.07	L	
29.28	16.22	L		27.65	10.88	"	
26.63	17.42	L		21.24	14.64	"	
23.06	19.54	"		11.84	23.97	" + TL	
22.05	20.95	" + TL					
12.34	19.66	TL					

SO $\text{Cd}_3^{\beta} = \text{CdSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$; $\text{D} = 3\text{CdSO}_4 \cdot \text{Tl}_2\text{SO}_4 \cdot 5\text{H}_2\text{O}$; $\text{L} = 2\text{CdSO}_4 \cdot \text{Tl}_2\text{SO}_4$;
 $\text{TL} = \text{Tl}_2\text{SO}_4$; $\text{CdI} = \text{CdSO}_4 \cdot \text{H}_2\text{O}$.

SOLUBILITY OF CADMIUM SULFATE IN ABSOLUTE METHYL AND ETHYL ALCOHOLS
 (Gibson, Driacoll, and Jones, 1929)

Results for Methyl Alcohol			Results for Ethyl Alcohol		
t°	Gms. CdSO ₄ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. CdSO ₄ per 100 gms. CH ₃ OH	Solid Phase
15	0.038	CdSO ₄	35	0.027	CdSO ₄
25	0.031	"	45	0.025	"
35	0.026	"	55	0.019	"
45	0.022	"			
55	0.019	"			

The solubility of Cadmium Sulfate in aqueous solutions of tertiary Butyl Alcohol was determined by the synthetic method and the composition of the homogeneous mixture (plait point) at 25°, found to be 8.1% CdSO₄, 21.3% tert. (CH₃)₃COH and 70.6% H₂O. Equations for the composition of the binodal curve are also given. (Ginnings, Herring and Bailey, 1933)

Similar data, showing the constants of the equations for the composition of the binodal curve for Cadmium Sulfate in aqueous solutions of allyl alcohol at 25° are given by Ginnings and Dees, 1935)

100 gms. 95% formic acid dissolve 0.06 gm. CdSO₄ at 18.5°. (Aschan, 1913)

Fusion-point data are given for mixtures of CdSO₄ + Li₂SO₄, CdSO₄ + K₂SO₄ and CdSO₄ + Na₂SO₄ by Calcagni and Marotta, 1913)

CADMIUM SELENATE CdSeO_4

SeO

SOLUBILITY IN WATER
(Klein, 1940)

The author found that evaporation of a saturated solution led to the precipitation of the dihydrate which, however, was not the stable phase. Prolonged agitation showed that the monohydrate was the stable phase at all temperatures from the eutectic to 100°. The composition of the solids in contact with the saturated solutions were determined at several temperatures, and the existence of the monohydrate was further confirmed by following the loss in weight of the dihydrate upon heating.

Grams CdSeO_4 per 100 gms.

t°	Density	Sat. Sol.	Water	Solid Phase
- 3.2	-	28.24	39.35	Ice
- 5.8	-	35.85	55.88	"
- 7.8	1.5520	39.54	65.39	"
(M) -11	-	43.47	76.89	Ice + $\text{CdSeO}_4 \cdot 2\text{H}_2\text{O}$
-10.8	-	-	-	Ice + $\text{CdSeO}_4 \cdot \text{H}_2\text{O}$
(M) 0	1.6241	42.76	74.70	$\text{CdSeO}_4 \cdot 2\text{H}_2\text{O}$
(M) 10	1.5950	42.16	72.89	"
(M) 20.2	1.5950	40.63	68.43	"
(M) 40	1.5015	37.80	60.77	"
(M) 54.2	1.4520	35.59	55.25	"
(M) 60.2	1.4306	34.37	52.36	"
(M) 70	-	32.48	48.0	"
- 9.5	-	43.28	76.30	"
- 4.8	1.6195	42.55	74.06	"
0	1.6048	42.01	72.44	"
10	1.5725	40.53	68.44	"
15	1.5555	39.52	65.40	"
17	1.5490	39.25	65.40	"
21.6	1.5337	38.89	63.64	"
26	1.5155	37.98	61.23	"
30	1.5012	37.07	58.90	"
35.2	1.4823	36.48	57.43	"
45	1.4412	34.44	52.53	"
48	1.4284	33.98	51.46	"
51.4	1.4074	32.87	48.96	"
56	1.3886	31.66	46.32	"
60	1.3664	30.65	44.20	"
62.4	1.3557	29.98	42.81	"
70	1.3158	27.93	38.75	"
80	1.2559	24.51	32.47	"
90	1.2035	21.45	27.16	"
98.5	-	18.04	22.01	"

(M) = Metastable

CADMIUM SILICATE CdSiO_3

SiO

Fusion-point data are given for $\text{CdSiO}_3 + \text{ZnSiO}_3$. (van Klooster, 1910-11)

Ce CERIUM

CERIUM Ce

The melting point diagram for the system Ce-CeCl₃ is given by Cubicciotti (1949) and Eastman, Cubicciotti and Thurmond (1950).

Br CERIUM BROMIDE CeBr₃

SOLUBILITY OF CERIUM BROMIDE IN PYRIDINE (Miller, 1932a)

t°	Gms. CeBr ₃ per 100 gms. sat. sol.	Solid Phase
- 5	0.437	CeBr ₃ ·3C ₅ H ₅ N
- 2	0.713	"
0	0.907	"
+ 3	1.33	" + 2CeBr ₃ ·3C ₅ H ₅ N
4	1.034	2CeBr ₃ ·3C ₅ H ₅ N
5	0.768	" + CeBr ₃ ·2C ₅ H ₅ N
8	1.215	CeBr ₃ ·2C ₅ H ₅ N
10	1.63	"
12	2.14	"
15	2.91	"
18	3.53	" + CeBr ₃ ·C ₅ H ₅ N
22	2.614	CeBr ₃ ·C ₅ H ₅ N
25	2.12	"
28	1.408	"
30	0.821	" + 3CeBr ₃ ·2C ₅ H ₅ N
40	0.791	CeBr ₃ ·2C ₅ H ₅ N
50	0.719	"
60	0.721	"
70	0.691	"
80	0.653	"

CH CERIUM ACETATE, BUTYRATE, FORMATE, PROPIONATE

SOLUBILITY IN WATER (Wolff, 1905)

Salt	Formula	Grams Anhydrous Salt per 100 Gms. Solution at:		
		11°	15°	70°
Acetate	Ce(C ₂ H ₃ O ₂) ₃ ·1½H ₂ O	...	19.61	12.97
Butyrate	Ce(C ₄ H ₇ O ₂) ₃ , and 3H ₂ O	3.544	3.406	1.084
Iso Butyrate	Ce(C ₄ H ₇ O ₂) ₃ ·3H ₂ O	...	6.603(20.4°)	3.39
Formate	Ce(CHO ₂) ₃	...	0.398(13°)	0.374(75.3°)
Propionate	Ce(C ₃ H ₅ O ₂) ₃ ·H ₂ O, and 3H ₂ O	...	18.99	15.93

CERIUM TRIFLUOROACETATE $(CF_3COO)_3Ce$

At 29.8° 0.101 gms. $(CF_3COO)_3Ce$ dissolve in 100 gms. CF_3COOH .
(Hara and Cady, 1954)

CERIUM GLYCOLATE $Ce(C_2H_3O_3)_3$

CH

One liter H_2O dissolves 3.563 gms. of the salt at 20°. (Jantsch and Grunkraut, 1912-13)

CERIUM MALONATE $Ce_2(C_3H_2O_4)_3 \cdot 6H_2O$

Solvent	t°	Gms. $Ce_2(C_3H_2O_4)_2$ per 100 Grams Solvent
Aq. Ammonium Malonate, containing 10 gms. per 100 cc	20	0.2
Aq. Malonic Acid, containing 20 gms. per 100 cc	20	0.6

(Holmberg, 1907)

CERIUM TARTRATE $Ce_2(C_4H_4O_6)_3 \cdot 4\frac{1}{2}H_2O$, also $\cdot 6H_2O$

CH

SOLUBILITY IN WATER (Rimbach and Ssubert, 1909, by electrolytic method)
AND IN AQ. SOLUTIONS. (Holmberg, 1907)

Solvent	t°	Gms. Anhydrous salt per 100 gms. Sat. Sol.	Solid Phase
Water	25	0.005	$Ce_2(C_4H_4O_6)_3 \cdot 4\frac{1}{2}H_2O$
Aq. Am. Tartrate, 10 Gms. per 100 cc	20	0.7	$Ce_2(C_4H_4O_6)_3 \cdot 6H_2O$
Aq. Am. Tartrate, 20 Gms. per 100 cc	20	2	"
Aq. Tartaric Acid, 20 Gms. per 100 cc	20	0.4	"
Aq. Tartaric Acid, 40 Gms. per 100 cc	20	0.2	"

CERIUM CITRATE $2(CeC_6H_5O_7) \cdot 7H_2O$

100 gms. of aq. citric acid solution containing 10 gms. citric acid
per 100 cc, dissolve 0.3 gm. $C_2(C_6H_5O_7)$ at 20°. (Holmberg, 1907)

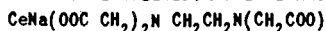
Ce CERIUM

CH CERIUM BENZENE SULFONATES

SOLUBILITY IN WATER
(Holmberg, 1907; Katz and James 1913)

Name	Formula	t°	Gms. Anhydrous Salt per 100 Gms. H ₂ O
Cerium m Nitrobenzene Sulfonate	$\text{Ce}[\text{C}_6\text{H}_4(\text{NO}_2)\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	15	25.5
Cerium Bromonitrobenzene Sulfonate	$\text{Ce}[\text{C}_6\text{H}_3\text{Br}(\text{NO}_2)\text{SO}_3]_3 \cdot 8\text{H}_2\text{O}$	25	5.89

CH CERIUM SODIUM ETHYLENEDIAMINE TETRACETATE



SOLUBILITY IN WATER
(Marsh, 1955)

2° - 28 gms. anhydrous salt per liter sat. sol.
25° - 70 gms. " " " " " "

CEROUS ELAIDATE, PALMITATE and STEARATE

SOLUBILITIES IN ETHER AND IN TURPENTINE
(Morrell, 1918)

Compound	Formula	Solvent	t°	Gms. compd. per 100 gms. sat. sol.
Cerous Elaidate	$\text{Ce}(\text{C}_{18}\text{H}_{33}\text{O}_2)_3$	Ether	cold	1.07
" Palmitate	$\text{Ce}(\text{C}_{16}\text{H}_{31}\text{O}_2)_3$	Ether	"	0.8
" "	"	Turpentine	"	0.18
" Stearate	$\text{Ce}(\text{C}_{18}\text{H}_{35}\text{O}_2)_3$	Ether	"	0.6

CERIUM Campho CARBONATE $\text{Ce}(\text{C}_{11}\text{H}_{15}\text{O}_3)_3$

CH

SOLUBILITY IN SEVERAL SOLVENTS
(Picon, 1931)

Gms. $\text{Ce}(\text{C}_{11}\text{H}_{15}\text{O}_3)_3$ per 100 cc sat. sol.			Gms. $\text{Ce}(\text{C}_{11}\text{H}_{15}\text{O}_3)_3$ per 100 cc sat. sol.		
Solvent	t°		Solvent	t°	
Water	20	0.68	Benzene	17	More than 70.0
Methyl alcohol	17	34.72	Chloroform	17	" " 70.0
Ethyl alcohol	17	37.44	Carbon tetra chloride	17	" " 50.0
Ethyl ether	17	5.28	Carbon Di Sulfide	17	" " 70.0
Acetone	17	6.51	Petroleum ether	17	0.0
Ethyl acetate	17	6.47	Oils	17	trace

CERIUM COBALTCYANIDE $2\text{Ce}(\text{CN})_3 \cdot 2\text{Co}(\text{CN})_3 \cdot 9\text{H}_2\text{O}$
 $(\text{Ce}[\text{Co}(\text{CN})_6] \cdot 4.5\text{H}_2\text{O})$

CM

100 gms. aq. 10% HCl ($d_{15} = 1.05$) dissolve 1.075 gms. of the salt at 25°. (James and Willand, 1916).

CERIUM FERROCYANIDE $\text{Ca}_4[\text{Fe}(\text{CN})_6]_3 \cdot 20\text{H}_2\text{O}$

The solubility at 25° is 1.3×10^{-4} mole/liter. (Tananaev and Seifer, 1956)

CERIUM $\left\{ \begin{array}{l} \text{SODIUM} \\ \text{POTASSIUM} \\ \text{RUBIDIUM} \\ \text{CAESIUM} \end{array} \right\}$ FERROCYANIDES

SOLUBILITY OF EACH IN WATER AT 25°
(Tananaev and Seifer, 1956)

Formula	Moles per liter sat. sol.
$\text{Ce}_3\text{Na}_4[\text{Fe}(\text{CN})_6] \cdot x\text{H}_2\text{O}$	2.1×10^{-4}
$\text{CeK}[\text{Fe}(\text{CN})_6] \cdot 2\text{H}_2\text{O}$	2.4×10^{-4}
$\text{CeRb}[\text{Fe}(\text{CN})_6] \cdot 2\text{H}_2\text{O}$	7.1×10^{-5}
$\text{CeCs}[\text{Fe}(\text{CN})_6] \cdot 2\text{H}_2\text{O}$	1.7×10^{-4}

CERIUM OXALATE $\text{Ce}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$

CO

One liter H_2O dissolves 0.00041 gm. $\text{Ce}_2(\text{C}_2\text{O}_4)_3$ at 25°, determined by the electrolytic method. (Rimbach and Schubert, 1909).

100 gms. of saturated solution in water contain 0.000109 gms. $\text{Ce}_2(\text{C}_2\text{O}_4)_3$ at 25°. (Sarver and Brinton, 1927).

Ce CERIUM

SOLUBILITY OF CERIUM OXALATE IN AQUEOUS SOLUTIONS OF ACIDS AT 25°
(Sarver and Brinton, 1927; Hauser and Wirth, 1908; Wirth, 1912*)

Solid Phase $\text{Ce}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$

	Gms. $\text{Ce}_2(\text{C}_2\text{O}_4)_3$ per 100 gms. sat. sol.	Gms. $\text{Ce}_2(\text{C}_2\text{O}_4)_3$ per 100 gms. sat. sol.	
Composition of Aq. Solvent in Normality	Composition of Aq. Solvent in Normality	Composition of Aq. Solvent in Normality	
H_2O alone	0.000109	0.50 $(\text{COOH})_2$ + .05 H_2SO_4	0.0166*
0.1008 $\text{HCl}\dagger$	0.0131	0.50 " + .50 "	0.0016*
0.2576 "	0.0376	0.2462 HNO_3	0.0355
CO 0.5004 "	0.0834	1.992 "	0.6808
1.018 "	0.2174	4.054 "	2.264
1.484 "	0.3552	2.00 " + 0.1 $(\text{COOH})_2$	0.3100
2.000 "	0.5518	3.03 " " "	0.9328
2.865 "	0.9354	4.00 " " "	1.738
0.978 " + 0.1 $(\text{COOH})_2$	0.0272	2.00 " 0.5 "	0.0526
2.000 " " "	0.2120	3.03 " " "	0.2604
2.865 " " "	0.5486	4.00 " " "	0.7934
3.965 " " "	1.152	4.00 " + satd. "	0.4014
0.978 " + 0.5 "	0.0049	6.00 " " "	1.328
2.000 " " "	0.0338	0.086 H_2SO_4	0.0142
2.865 " " "	0.1142	0.1 "	0.0215*
3.965 " " "	0.3808	0.419 "	0.0683
1.484 " + satd. "	0.0068	0.5 "	0.0828*
4.00 " + " "	0.0313	0.958 "	0.1738
6.00 " + " "	0.1862	1.0 "	0.1802*
6.20 " + " "	0.1604	1.445 "	0.2788*
0.1 $(\text{COOH})_2$	0.0032*	1.846 "	0.3820
0.5 "	0.0131*	2.39 "	0.4871*
1.0 "	0.0063*	2.612 "	0.5904
3.2 " (sat.)	0.0030*	2.9 "	0.7467*
0.05 " + .05 H_2SO_4	0.0047*	3.9 "	0.9957*
0.05 " + .5 "	0.0039*	4.32 "	1.1860*
0.25 " + .25 "	0.0073*	5.3 "	1.4250*

†Korenman, 1954 found the K_{sp} in 0.1N HCl to be 1.10×10^{-28} at 20°.

SOLUBILITY OF CERIUM OXALATE IN OXALATE SOLUTIONS AT 25°
(Crouthamel and Martin, Jr., 1951)

The determinations were made in buffered oxalate solutions by using a radioactive cerium 141 sample.

[selected data]							
\sqrt{m}	pH	Total C ₂ O ₄ ⁻⁻ moles per liter	Ce ⁺⁺⁺ moles per liter	\sqrt{m}	pH	Total C ₂ O ₄ ⁻⁻ moles per liter	Ce ⁺⁺⁺ moles per liter
0.607	5.85	0.126	0.000069	0.076	4.11	0.0031	0.0000028
.425	4.25	.085	.000040	.062	3.09	.0034	.0000015
.230	7.60	.018	.000015	.100	2.03	.011	.0000022
.182	5.22	.012	.0000096	.245	1.25	.026	.0000043
.094	6.90	.0030	.0000046	.570	0.62	.0028	.0011

CEROUS CHLORIDE CeCl_3

Cl

100 cc. anhydrous hydrazine dissolve 3 gms. CeCl_3 , with evolution of gas, at room temp. (Welsh and Broderson, 1915).

100 gms. pyridine dissolve 1.58 gms. CeCl_3 at 0° . (Muller, R., 1924).

Melting point data are given for:

$\text{CeCl}_3 + \text{KCl}$	(Kojima, 1952)
$\text{CeCl}_3 + \text{KCl} + \text{NaCl}$	(" ")
$\text{CeCl}_3^* + \text{CaCl}_2$	} (Nishihara and Ando, 1949)
$\text{CeCl}_3^* + \text{BaCl}_2$	
$\text{CeCl}_3^* + \text{CaCl}_2 + \text{BaCl}_2$	

(* = 89.23% CeCl_3 + 10.77% other cerium group chlorides)

$\text{CeCl}_3^\dagger + \text{NaCl}$ (Nishihara, Shimizu and Katori, 1950)

(\dagger = 80% CeCl_3 + 20% other cerium group chlorides)

$\text{CeCl}_3^\Delta + \text{CaCl}_2$	} (Nishihara, Tsuda and Shimizu, 1952)
$\text{CeCl}_3^\Delta + \text{BaCl}_2$	
$\text{CeCl}_3^\Delta + \text{NaCl}$	

+ all 3 ternary systems.

(Δ = 89% CeCl_3 + 11% other cerium group chlorides)

CERIUM Hexa Antipyrine PERCHLORATE $[\text{Ce}(\text{COC}_{10}\text{H}_{12}\text{H}_2)_6](\text{ClO}_4)_3$

ClO

100 gm. sat. solution in water contain 1.07 gm. of the salt at 20° . (Wilke Dorfurt and Schliephake, 1925).

CEROUS FLUORIDE CeF_3 CERIC FLUORIDE CeF_4 SOLUBILITY IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

CeF_3		CeF_4	
t°	Gms. CeF_3 per 100 gms. HF	t°	Gms. CeF_4 per 100 gms. HF
-25.2	0.041	-23.8	0.106
- 7.8	0.037	- 9.8	0.10
+11.9	0.043	+11.9	0.10

Freezing-point lowering data are given for mixtures of $\text{CeF}_3 + \text{KF}$ by Puschin and Baskow, 1913.

Ce CERIUM

IO CERIUM IODATE $\text{Ce}(\text{IO}_3)_3$

One liter sat. aqueous solution contains 1.456 gms. $\text{Ce}(\text{IO}_3)_3$, determined by a chemical method, and 1.636 gms. determined electrolytically. (Rimbach and Schubert, 1909.)

1000 gms. H_2O dissolve 1.732 gms. $\text{Ce}(\text{IO}_3)_3$ at 25° . (Chleupek, Danes and Danesova, 1932.)

SOLUBILITY OF CERIUM IODATE IN AQUEOUS SOLUTIONS OF SALTS AT 25° (Chleupek, Danes and Danesova, 1932)

In Aqueous Solutions of:

Potassium Nitrate		Potassium Sulfate	
Molality of aq. KNO_3	Gms. $\text{Ce}(\text{IO}_3)_3$ per 1000 gms. H_2O	Molality of K_2SO_4	Gms. $\text{Ce}(\text{IO}_3)_3$ per 1000 gms. H_2O
0.005	1.846	0.0 (= H_2O)	1.732
0.01	1.932	0.002	2.013
0.02	2.097	0.005	2.370
0.05	2.418	0.01	2.819
0.10	2.736	0.02	3.510
0.20	3.120	0.05	4.529
0.50	3.976	0.10	5.660

Magnesium Sulfate		Magnesium Chloride	
Molality of MgSO_4	Gms. $\text{Ce}(\text{IO}_3)_3$ per 1000 gms. H_2O	Molality of MgCl_2	Gms. $\text{Ce}(\text{IO}_3)_3$ per 1000 gms. H_2O
0.002	2.056	0.002	1.870
0.005	2.442	0.005	1.993
0.01	3.917	0.01	2.169
0.02	3.508	0.02	2.427
0.05	4.695	0.05	2.983
0.10	6.025	0.10	3.533

NO CERIOUS NITRATE $\text{Ce}(\text{NO}_3)_3$

SOLUBILITY IN WATER (Quill and Robey, 1937)

t°	d. of sat. sol.	Gms. $\text{Ce}(\text{NO}_3)_3$ per 100 gms. sat. sol.	Solid Phase
25	1.880	63.71	$\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ "
50	2.040	73.88	

DISTRIBUTION OF CERIOUS NITRATE BETWEEN WATER AND n-HEXYL ALCOHOL AT 25°
(Templeton, 1949)

Gms. CeO ₂ per 100 Gms. Sat. Sol.		Gms. CeO ₂ per 100 gms. Sat. Sol.	
Aqueous Phase	Alcohol Phase	Aqueous Phase	Alcohol Phase
30.3	2.87	26.2	0.85
29.57	2.34	24.47	.57
28.5	1.70	22.83	.34
27.57	1.28	21.5	.26

SOLUBILITY IN ETHYL ETHER

t°	Solute	Solubility					
17	Ce(NO ₃) ₃ ·6H ₂ O	3.43 gms.	Ce(NO ₃) ₃	per liter	(C ₂ H ₅) ₂ O	(Bachelet, Cheylan and LeBris, 1950)	
20	Ce(NO ₃) ₃ ·6H ₂ O	2.63	"	"	"	sat. sol.	(Wells, 1930)
20	Ce(NO ₃) ₃	0.19	"	"	"	"	(" ")

Data for the partition of Cerium compounds in nitrate solutions between ethers, ketones, nitromethane and 1M HNO₃ at 20° are given by Bock and Bock, 1950.

CERIC NITRATE Ce(NO₃)₄

NO

10 ml. of a saturated solution of cerium nitrate in ether contain 13.9 mg. CeO₂. (Wells, 1930.)

CEROUS AMMONIUM NITRATE Ce(NO₃)₃·2NH₄NO₃·4H₂O

CERIC AMMONIUM NITRATE Ce(NO₃)₄·2NH₄NO₃

SOLUBILITY OF EACH IN WATER
(Wolff, 1905)

Cerous			Ceric		
	Gms. $\text{Ce}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$ per 100 Gms.			Gms. $\text{Ce}(\text{NO}_3)_4 \cdot 2\text{NH}_4\text{NO}_3$ per 100 Gms.	
t°	Solution	Water	t°	Solution	Water
8.75	70.2	235.5	25	58.49	140.9
25.0	74.8	296.8	35.2	61.79	161.7
45.0	80.4	410.2	45.3	64.51	174.9
60.0	87.2	681.2	64.5	66.84	201.6
65.06	89.1	817.4	85.6	69.40	226.8
			112	88.03	735.4

Ce CERIUM

NO CERIUM MAGNESIUM NITRATE $2\text{Ce}(\text{NO}_3)_3 \cdot 3\text{Mg}(\text{NO}_3)_2 \cdot 24\text{H}_2\text{O}$

SOLUBILITY OF THE HYDRATED SALT IN WATER (Friend and Wheat, 1935)

t°	11°	16°	24.6°	31.8°	42.2°	57.0°	111.5°
Gms. $2\text{Ce}(\text{NO}_3)_3 \cdot 3\text{Mg}(\text{NO}_3)_2 \cdot 24\text{H}_2\text{O}$ per 100 gms. sat. sol.	61.98	62.89	65.63	66.20	69.26	72.78	100



SOLUBILITY OF EACH IN CONCENTRATED NITRIC ACID SOLUTIONS AT 16° (Jantsh, 1912)

The solvent had density $\frac{16}{4} = 1.325$ and contained 51.59 gms. HNO_3 per 100 cc.

Cerium magnesium nitrate, 1 liter sat. solution contains 58.5 gms.
 $[\text{Ce}(\text{NO}_3)_6]\text{Mg}_3 \cdot 24\text{H}_2\text{O}$.

Cerium nickel nitrate, 1 liter sat. solution contains 75.3 gms.
 $[\text{Ce}(\text{NO}_3)_6]\text{Ni}_3 \cdot 24\text{H}_2\text{O}$.

Cerium cobalt nitrate, 1 liter sat. solution contains 103.3 gms.
 $[\text{Ce}(\text{NO}_3)_6]\text{Co}_3 \cdot 24\text{H}_2\text{O}$.

Cerium zinc nitrate, 1 liter sat. solution contains 111.7 gms.
 $[\text{Ce}(\text{NO}_3)_6]\text{Zn}_3 \cdot 24\text{H}_2\text{O}$.

Cerium manganese nitrate, 1 liter sat. solution contains 178.8 gms.
 $[\text{Ce}(\text{NO}_3)_6]\text{Mn}_3 \cdot 24\text{H}_2\text{O}$.

OH CERIOUS HYDROXIDE $\text{Ce}(\text{OH})_3$

SOLUBILITY IN WATER (at room temperature, by potentiometric titration)

4.0×10^{-6} moles/liter	(Oka, 1940)
4.8×10^{-6} " "	(Moeller and Kremers, 1944)
1.2×10^{-6} " "	(Korenman, 1955)

SOLUBILITY OF Ce_2O_3 IN ROCHELLE SALT SOLUTIONS
(Deshmukh and Nayak, 1951)

Read from the curve drawn by the authors.

Wt% Rochelle Salt in Solvent:	5	10	15	20
Gms. Ce_2O_3 per 100 ml sat. sol.	0.4	0.5	0.9	1.9

Data for the precipitation of Ce_2O_3 and other rare earth oxides from ammonium acetate solutions at 15° is given by Perey, 1949.

CERRIC HYDROXIDE $\text{Ce}(\text{OH})_4$

OH

Korenman, 1955 found the Ksp to be 2×10^{-48} .

Vickery, 1949 found 0.50 gms. $\text{Ce}(\text{OH})_4$ dissolved in 10 gms. of fused NH_4NO_3 at 130° .

Data for the distribution of ceric oxide between aqueous solutions of nitric acid and ethyl ether are given by Imre, 1927.

CERIC PHOSPHATE $\text{Ce}_2(\text{PO}_4)_3$

PO

SOLUBILITY OF CERIC PHOSPHATE IN AQUEOUS SOLUTIONS AT 100°
(Atanasiu and Babor, 1938)

Ceric phosphate was precipitated from acid solution and the solubility determined under different treatments. Drying at 110° produced the salt $\text{Ce}_3(\text{PO}_4)_4 \cdot 11\text{H}_2\text{O}$.

% Solubility

Solvent	Freshly precipitated	Dried at 100°	Ignited
Water or 10% HAC	0	0	0
5% H_2SO_4	0.083	0.08	0
10% H_2SO_4	0.14	0.15	0
5% HCl	0.02	0.2	0
10% HCl	0.05	0.3	0
5% HNO_3	0.12	0.1	0
10% HNO_3	0.18	0.15	0
60% HNO_3	soluble	soluble	0.1

Ca CERIUM

PO CERIC PYROPHOSPHATE CeP_2O_7

SOLUBILITY OF CERIC PYROPHOSPHATE IN HYDROCHLORIC ACID SOLUTIONS AT 20° (Moeller and Schweitzer, 1948)

Radioactive pyrophosphate was added to an excess of ceric ion and the precipitated CeP_2O_7 was washed and dried. These samples were shaken for 36 hours with the acid solutions and then filtered off. The radioactive count in solution was used as the measure of the solubility. The data below were read from the curve drawn by the authors:

Normality of HCl	0.05	0.10	0.20	0.30
Moles CeP_2O_7 per liter:	1.1×10^{-4}	2.0×10^{-4}	3.2×10^{-4}	4.3×10^{-4}

SOLUBILITY IN SULFURIC ACID SOLUTIONS (Brantley and Huizeng, 1952)

H_2SO_4 Normality	0	0.114	0.228	0.342	0.684
CeP_2O_7 {gms./liter	7×10^{-5}	2.6×10^{-2}	4.6×10^{-2}	7.3×10^{-2}	0.21
{moles/liter	2×10^{-7}	8×10^{-5}	1.5×10^{-4}	2.3×10^{-4}	6.6×10^{-4}

CERIUM Dimethyl PHOSPHATE $\text{Ce}_2[(\text{CH}_3)_2\text{PO}_4]_3 \cdot \text{H}_2\text{O}$

100 gms. H_2O dissolve 79.6 gms. $\text{Ce}_2[(\text{CH}_3)_2\text{PO}_4]_3$ at 25° and about 65 gms. at 95°. (Morgan and James, 1914)

3 CEROUS SULFIDE Ce_2S_3

The Ksp is calculated to be 6×10^{-11} by Goates, Gorden, and Faux, 1952.

30 CERIUM SULFATE $\text{Ce}_2(\text{SO}_4)_3$

SOLUBILITY OF THE SEVERAL HYDRATES IN WATER (Koppel, 1904; Voogd, 1933)

A most unusual relationship exists in which the 8-hydrate is stable at a lower temperature than the 9-hydrate. Voogd found the transition $\text{Ce}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O} + \text{aq.} \rightarrow \text{Ce}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ to occur at 30.4°. All but the 12-hydrate become less soluble with increasing temperature. The 5-hydrate appears to be wholly metastable.

Results of Koppel, 1904; the older determinations by Mithman and Rolig, 1898, and by Wyrouboff, 1901, are shown by Koppel to be inaccurate.)

t°	Gms. Ce ₂ (SO ₄) ₃ per 100 gms. Solution	Gms. Ce ₂ (SO ₄) ₃ per 100 Mols. H ₂ O	Solid Phase	
0	14.20	0.525	Ce ₂ (SO ₄) ₃ · 12H ₂ O	
18.8	14.91	0.555	"	
19.2	15.04	0.561	"	
0	17.35	0.665	Ce ₂ (SO ₄) ₃ · 9H ₂ O	
15	10.61	0.376 ^a	"	30
21	8.863	0.308	"	
31.6	6.686	0.227	"	
45.6	4.910	0.164	"	
50	4.465	0.148	"	
60	3.73	0.123	"	
65	3.47	0.114	"	
0	15.95	0.605	Ce ₂ (SO ₄) ₃ · 8H ₂ O	
15	9.95	0.350	"	
20.5	8.69	0.302	"	
40	5.613	0.188	"	
60	3.88	0.129	"	
45	8.116	0.280	Ce ₂ (SO ₄) ₃ · 5H ₂ O	
60	3.145	0.103	"	
80	1.19	0.0382	"	
100.5	0.46	0.0149	"	
35	7.8	0.27	Ce ₂ (SO ₄) ₃ · 4H ₂ O	
40	5.71	0.19	"	
50	3.31	0.11	"	
65	1.85	0.06	"	
82	0.98	0.032	"	
100.5	0.42	0.014	"	

Results of Voogd, 1933
(confirming the data of Koppel, above)

t°	Gms. Ce ₂ (SO ₄) ₃ per 100 gms. H ₂ O	Solid Phase	t°	Gms. Ce ₂ (SO ₄) ₃ per 100 gms. H ₂ O	Solid Phase
0	18.83	Ce ₂ (SO ₄) ₃ · 8H ₂ O	0	21.37	Ce ₂ (SO ₄) ₃ · 9H ₂ O
20	9.431	"	20	9.845	"
25	8.211	"	25	8.363	"
30.4	7.102	"	30	7.241	"
35	6.385	"	35	6.349	"
40	5.700	"	40	5.632	"
45	5.153	"	45	5.036	"

Spedding and Jaffe, 1954 report the solubility of "hydrated cerium sulfate" to be 5.063 gms. per 100 gms. H₂O at 25°.

Ce CERIUM

SOLUBILITY OF CERIUM SULFATE IN AQ. SOLUTIONS OF SULFURIC ACID AT 25° (Wirth, 1912)

Normality of Aq. H ₂ SO ₄	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	CeO ₂	Ce ₂ (SO ₄) ₂	
0.0	4.604	7.60	Ce ₂ (SO ₄) ₃ ·8H ₂ O
0.1	4.615	7.618	"
1.1	3.64	6.000	"
2.16	3.04	5.018	"
4.32	2.00	3.301	"
6.685	0.9115	1.505	"
9.68	0.4439	0.733	"
15.15	0.145	0.239	"

THE SYSTEM CERIUM SULFATE - POTASSIUM SULFATE - WATER (Schroder and Schackmann, 1934)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Ce ₂ (SO ₄) ₃	K ₂ SO ₄		Ce ₂ (SO ₄) ₃	K ₂ SO ₄	

Results at 0°			Results at 25°--Contd.		
13.93	0.0	Ce12	0.461	0.307	1.1.2
14.06	0.0	Ce8	0.356	0.471	"
13.94	0.012	1.1.2	0.321	0.657	" + 2.3.8
9.79	0.073	"	0.285	0.686	2.8.3
6.11	0.107	"	0.218	0.934	"
5.58	0.107	" + 2.3.8	0.189	0.983	"
4.12	0.142	2.3.8	0.157	1.056	" + 1.4
2.04	0.217	"	0.117	1.148	1.4 (-5)
1.10	0.279	"	0.043	1.395	"
0.631	0.407	"	0.002	2.641	"
0.190	0.692	" + 1.4	-	9.06	"
0.158	0.724	1.4(-5)	-	10.71	" + K
0.091	0.812	"	-	10.75	K
0.018	1.353	"	Results at 50°		
-	6.212	"			
-	6.870	" + K	4.622	0.0	Ce8
-	6.850	K	3.327	0.0	Ce4
Results at 25°			4.278	0.011	" + 1.1.2
(See also p. 777)			3.735	0.021	1.1.2
			1.904	0.062	"
7.77	0.0	Ce8	0.776	0.132	"
8.01	-	" + 1.1.2	0.460	0.190	"
7.27	0.032	1.1.2	0.279	0.320	"
4.63	0.062	"	0.160	0.532	"
2.60	0.083	"	0.083	0.819	"
1.09	0.142	"	0.078	1.482	" + 1.4
0.642	0.202	"	0.055	1.651	1.4 (-5)

(Cont.)

Ce12 = Ce₂(SO₄)₃·12H₂O; Ce8 = Ce₂(SO₄)₃·8H₂O; Ce4 = Ce₂(SO₄)₃·4H₂O
 1.1.2 = Ce₂(SO₄)₃·K₂SO₄·2H₂O; 2.3.8 = 2Ce₂(SO₄)₃·3K₂SO₄·8H₂O;
 1.4 (-5) = Ce₂(SO₄)₃·4K₂SO₄ (or 5K₂SO₄); K = K₂SO₄.

Gms. per 100 gas. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$Ce_2(SO_4)_3$	K_2SO_4		$Ce_2(SO_4)_3$	K_2SO_4	
Results at 50°-Contd.			Results at 75°-Contd.		
0.34	2.029	1.4 (-5)	0.697	0.101	1.1.2
0.016	2.289	"	0.384	0.144	"
-	7.39	"	0.134	0.324	"
-	11.33	"	0.065	0.545	"
-	13.64	" + K	0.040	1.549	"
-	14.14	K	0.019	2.197	"
Results at 75°			0.023	2.278	" + 1.4 30
			-	3.11	1.4 (-5)
1.076	0.0	Ce_4	-	5.20	"
1.150	0.019	"	-	8.63	"
1.356	0.061	" + 1.1.2	-	11.72	"
1.148	0.068	1.1.2	-	14.89	"
			-	17.15	K

$Ce_{12} = Ce_2(SO_4)_3 \cdot 12H_2O$; $Ce_8 = Ce_2(SO_4)_3 \cdot 8H_2O$; $Ce_4 = Ce_2(SO_4)_3 \cdot 4H_2O$;
 $1.1.2 = Ce_2(SO_4)_3 \cdot K_2SO_4 \cdot 2H_2O$; $2.3.8 = 2Ce_2(SO_4)_3 \cdot 3K_2SO_4 \cdot 8H_2O$;
 $1.4 (-5) = Ce_2(SO_4)_3 \cdot 4K_2SO_4$ (or $5K_2SO_4$); $K = K_2SO_4$.

Results of Barre, 1910 at 16° and 33°
 [The 1:1:2, 2:3:8, and 1:5 double salts were found]

Gms. per 100 Gms. H_2O	
K_2SO_4	$Ce_2(SO_4)_3$
0.0	10.747
0.178	0.956
0.510	0.432
0.726	0.250
1.290	0.042
(0.0)	(6.949) (at 33°)

Results of Zambonini and Restaino, 1926a at 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
K_2SO_4	$Ce_2(SO_4)_3$		K_2SO_4	$Ce_2(SO_4)_3$	
0.02	7.95	1.1.2	1.43	0.05	1.4 $\frac{1}{2}$
0.04	6.66	"	1.77	0.00	"
0.07	4.88	"	2.87	0.00	"
0.12	3.48	"	4.65	0.00	"
0.16	1.75	" + 2.3.8	5.56	0.00	1.5
0.79	0.30	2.3.8	6.22	0.00	"
1.26	0.12	" + 1.4 $\frac{1}{2}$	7.72	0.00	"
1.13	0.15	" "	9.22	0.00	"
1.17	0.13	" "	9.66-9.80	0.00	" + K_2SO_4

$1.1.2 = Ce_2(SO_4)_3 \cdot K_2SO_4 \cdot 2H_2O$; $2.3.8 = 2Ce_2(SO_4)_3 \cdot 3K_2SO_4 \cdot 8H_2O$; $1.4\frac{1}{2} = Ce_2(SO_4)_3 \cdot 1.4\frac{1}{2}K_2SO_4$; $1.5 = Ce_2(SO_4)_3 \cdot 5K_2SO_4$.

THE SYSTEM CERIUM SULFATE - SODIUM SULFATE - WATER
Results of Barre, 1910 at 19°

[The 1:1:2 double salt was found]

Gms. per 100 Gms. H ₂ O	
Na ₂ SO ₄	Ce ₂ (SO ₄) ₃
0.0	9.648
0.328	0.637
0.684	0.259
1.091	0.0937
1.392	0.0570
1.699	0.0303
2.640	0.0120
3.589	0.0065
5.660	0.0040
7.710	0.0037

\$0

Results of Zambonino and Restaino, 1927 at 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Na ₂ SO ₄	Ce ₂ (SO ₄) ₃		Na ₂ SO ₄	Ce ₂ (SO ₄) ₃	
15.34	-	4.5.8 + Na ₂ SO ₄	7.51	-	4.5.8
13.75	-	4.5.8	5.50	-	1.1.2
12.41	-	"	1.92	-	"
10.95	-	"	0.14	9.35	"
9.99	-	"	0.14	3.59	1.1.2 + Ce ₂ (SO ₄) ₃ ·8H ₂ O
			1.13	4.04	"

1.1.2 = Ce₂(SO₄)₃·Na₂SO₄·2H₂O; 4.5.8 = 4Ce₂(SO₄)₃·5K₂SO₄·8H₂O.

THE SYSTEM CERIUM SULFATE - AMMONIUM SULFATE - WATER AT 25°
(Schröder, Kehren, Frings and van Poelvoorde, 1938)

The authors also give similar results for the isotherms at 0°, 28°, 33°, 38°, 50°, 75°, 85° and 99.5°. By means of these extensive determinations the solubility relations of the various hydrates and double salts in this system have been completely established. The older determinations of Zambonini and Restaino, 1926 (at 25°) did not show the presence of the 1:1:2 compound.

density sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	$(\text{NH}_4)_2\text{SO}_4$	$\text{Ce}_2(\text{SO}_4)_3$	
1.0775	0.0	7.78	Ce8
1.0791	0.056	7.81	"
1.0813	0.279	7.94	"
1.0870	0.601	8.23	" + 1.1.8
1.0818	0.615	7.88	1.1.8
1.0746	0.644	7.32	"
1.0664	0.695	6.33	"
1.0576	0.751	5.44	"
-	0.840	4.61	"
1.0416	0.923	3.97	"
1.0377	1.010	3.46	"
1.0337	1.105	2.99	"
1.0291	1.320	2.54	"
1.0263	1.769	1.73	"
1.0258	2.320	1.25	"
1.303	3.775	0.853	"
1.0455	7.031	0.845	"
1.0554	8.588	0.798	"
1.0715	11.27	0.780	"
1.1043	16.92	0.785	"
1.1573	25.98	0.779	"
1.1664	28.49	0.454	" + 1.4 (5)
1.0829	0.327	7.931	Ce8 + 1.1.2
1.0687	0.357	6.876	1.1.2
1.0402	0.461	3.942	"
1.0242	0.572	2.451	"
1.0174	0.792	1.754	"
1.0138	1.093	1.402	"
1.0169	2.121	0.708	"
1.0449	7.637	0.322	"
1.1272	21.89	0.281	"
1.1664	28.72	0.239	"
1.1765	30.61	0.187	" + 1.4 (5)
1.1780	30.13	0.413	1.4 (5)
1.1835	31.60	0.325	"
1.1860	31.92	0.305	"
1.1964	32.94	0.248	"
1.2220	38.70	0.062	"
1.2434	43.17	-	" + $(\text{NH}_4)_2\text{SO}_4$
1.2419	43.42	0.0	$(\text{NH}_4)_2\text{SO}_4$

$\text{Ce8} = \text{Ce}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$; $1.1.8 = \text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$;
 $1.1.2 = \text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$; $1.4 (5) = \text{Ce}_2(\text{SO}_4)_3 \cdot 4 (\text{or } 5) (\text{NH}_4)_2\text{SO}_4$.

(Cont.)

Ce CERIUM

Results of Barre (1910) at 16°
[The 1:1:8 and 1:5:0 double salts were found]

Gms. per 100 Gms. H ₂ O		Gms. per 100 Gms. H ₂ O	
(NH ₄) ₂ SO ₄	Ce ₂ (SO ₄) ₃	(NH ₄) ₂ SO ₄	Ce ₂ (SO ₄) ₃
0.0	10.747	45.616	0.497
3.464	1.026	55.083	0.194
9.323	0.782	63.920	0.090
19.240	0.748	72.838	0.035
29.552	0.701		

50 CERIUM AMMONIUM SULPHATE Ce₂(SO₄)₃·(NH₄)₂SO₄·8H₂O

SOLUBILITY IN WATER
(Wolff, 1905)

t°	Gms. Ce ₂ (SO ₄) ₃ ·(NH ₄) ₂ SO ₄ per 100 gms.		Solid Phase	t°	Gms. Ce ₂ (SO ₄) ₃ ·(NH ₄) ₂ SO ₄ per 100 gms.		Solid Phase
	Solution	Water			Solution	Water	
22.3	5.06	5.33	·8H ₂ O	45.0	2.91	2.99	Anhydrous Salt
35.1	4.93	5.18	"	55.25	2.16	2.21	" "
45.2	4.76	4.99	"	75.4	1.46	1.48	" "
				85.2	1.17	1.18	" "

THE SYSTEM CERIUM SULFATE - THALLIUM SULFATE - WATER AT 25°
(Zambonini and Restaino, 1926a)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Tl ₂ SO ₄	Ce ₂ (SO ₄) ₃		Tl ₂ SO ₄	Ce ₂ (SO ₄) ₂	
1.01	1.02	1.1.4	2.52	0.14	1.3.1
1.14	0.65	"	2.44	0.16	" + 1.4 ₂ ¹
1.23	0.54	"	2.55	0.12	" "
1.80	0.32	"	3.46	0.05	1.4 ₂ ¹
1.90	0.33	"	5.33	0.00	"
2.35	0.24	" + 1.3.1	5.21	0.00	
2.29	0.18	" "	5.45	0.00	
2.41	0.17	" "			

1.1.4 = Ce₂(SO₄)₃·Tl₂SO₄·4H₂O; 1.3.1 = Ce₂(SO₄)₃·3Tl₂SO₄·H₂O;
1.4₂¹ = Ce₂(SO₄)₃·4₂Tl₂SO₄.

THE SYSTEM CERIUM SULFATE - CESIUM SULFATE - WATER AT 25°
(Zambonini and Restaino, 1929)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Cs_2SO_4	$Ce_2(SO_4)_3$		Cs_2SO_4	$Ce_2(SO_4)_3$	
46.85	-	1.1.8 + Cs_2SO_4	4.33	3.67	1.1.8
41.74	-	1.1.8	2.29	4.20	"
33.90	-	"	1.46	5.38	"
22.45	-	"	0.45	8.06	" + $Ce_2(SO_4)_3 \cdot 8H_2O$
6.02	-	"			

30

1.1.8 = $Ce_2(SO_4)_3 \cdot Cs_2SO_4 \cdot 8H_2O$.

CERIUM SELENATE $Ce_2(SeO_4)_3$

3e0

SOLUBILITY IN WATER
(Cingolani, 1908)

t°	Gms. $Ce_2(SeO_4)_3$ per 100 Gms. H_2O	Solid Phase	t°	Gms. $Ce_2(SeO_4)_3$ per 100 Gms. H_2O	Solid Phase
0	39.55	$Ce_2(SeO_4)_3 \cdot 12H_2O$	60	13.68	$Ce_2(SeO_4)_3 \cdot 8H_2O$
11.6	37.0	"	60.8	13.12	"
12.6	36.9	$Ce_2(SeO_4)_3 \cdot 11H_2O$	78.2	5.53	"
26	33.84	"	80.5	4.56	$Ce_2(SeO_4)_3 \cdot 7H_2O$
28.8	33.22	"	91	2.02	"
34.2	33.15	$Ce_2(SeO_4)_3 \cdot 10H_2O$	95.4	1.536	$Ce_2(SeO_4)_3 \cdot 4H_2O$
45	32.16	"	98	1.785	"
45.9	31.89	"	100	2.513	"

CERIUM TUNGSTATE $Ce_2(WO_4)_3$

W0

SOLUBILITY OF CERIUM TUNGSTATE IN WATER
(Vickery, 1949)

t°	Unignited		Ignited	
20	0.014	gms./100 ml.	0.001	gms./100 ml.
100	0.020	"	.001	"

Cl CHLORINE

THE SYSTEM CERIUM TUNGSTATE - SODIUM TUNGSTATE - WATER AT 25° (Carobbi, 1928)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Na_2WO_4	$\text{Ce}_2(\text{WO}_4)_3$		Na_2WO_4	$\text{Ce}_2(\text{WO}_4)_3$	
2.65	0.62	Ce aq + 1.1.11	23.32	0.40	1.3.16
4.00	0.60	1.1.11	25.35	0.32	"
6.13	0.52	"	27.64	0.24	" + 1.5.23
10.71	0.56	"	30.24	0.15	1.5.23
13.28	0.48	"	35.07	trace	"
14.24	0.60	"	37.42	-	"
15.03	0.57	" + 1.3.16	39.90	-	"
17.98	0.42	1.3.16	42.14	-	"
20.03	0.39	"	42.62	-	" + $\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$

Ce aq. = $\text{Ce}_2(\text{WO}_4)_3 \cdot \text{Hydrate}$; 1.1.11 = $\text{Ce}_2(\text{WO}_4)_3 \cdot \text{Na}_2\text{WO}_4 \cdot 11\text{H}_2\text{O}$;
1.3.16 = $\text{Ce}_2(\text{WO}_4)_3 \cdot 3\text{Na}_2\text{WO}_4 \cdot 16\text{H}_2\text{O}$; 1.5.23 = $\text{Ce}_2(\text{WO}_4)_3 \cdot 5\text{Na}_2\text{WO}_4 \cdot 23\text{H}_2\text{O}$.

Fusion-point data for mixtures of $\text{Ce}_2(\text{WO}_4)_3$ and PbWO_4 are given by Zambonini, 1913.

CHLORINE Cl_2

SOLUBILITY IN WATER

(Winkler, 1912; Rooseboom, 1884, 1855, 1888; see also Goodwin, 1882, Arkadiev, 1918)

β = vol. of Cl_2 (reduced to 0° and 760 mm.) absorbed by 1 vol. H_2O at total pressure of 760 mm.

q = Gms. Cl_2 per 100 gms. H_2O at a total pressure of 760 mm.

t°	β	q	t°	Gms. Cl_2 per 100 Gms. H_2O	Solid Phase
0	4.610	1.46	-0.24	0.492	Ice + Cl_2 . 8 aq.
3	3.947	1.25	0	0.507-0.560	Cl_2 . 8 aq.
6	3.411	1.08	+2	0.644	"
9	3.031	0.96	4	0.732	"
9.6	2.980	0.94	6	0.823	"
12	2.778	0.88	8	0.917	"
10	3.095	0.980	9	0.965-0.908	"
15	2.635	0.835	20	1.85	"
20	2.260	0.716	28.7	3.69	" + 2 layers
25	1.985	0.630			
30	1.769	0.562			
40	1.414	0.451			
50	1.204	0.386			
60	1.006	0.324			
70	0.848	0.274			
80	0.672	0.219			
90	0.380	0.125			
100	0	0			

SOLUBILITY OF CHLORINE IN WATER AT LESS THAN 1 ATMOSPHERE PRESSURE
(Whitney and Vivian, 1941)

The authors passed various mixtures of Chlorine + Nitrogen through Water and analyzed both the gas phase and the saturated solution. Hydrolysis constants were calculated. A nomograph has been constructed from the data by Davis, 1941b.

10°		15°		20°		25°	
Part. Gms. Cl ₂ Pres. per 100 Cl ₂ (Atm) gms. H ₂ O		Part. Gms. Cl ₂ Pres. per 100 Cl ₂ (Atm) gms. H ₂ O		Part. Gms. Cl ₂ Pres. per 100 Cl ₂ (Atm) gms. H ₂ O		Part. Gms. Cl ₂ Pres. per 100 Cl ₂ (Atm) gms. H ₂ O	
0.061	0.124	0.0581	0.111	0.0665	0.112	0.0621	0.104
.0660	.131	.0611	.115	.1195	.160	.0655	.106
.155	.228	.140	.195	.260	.263	.104	.139
.157	.237	.145	.201	.487	.415	.109	.143
.292	.368	.291	.330	.490	.422	.174	.189
.293	.366	.297	.330	.965	.725	.270	.246
.498	.541	.488	.477			.551	.391
.498	.555	.490	.480			.589	.418
		.951	.825			.961	.628

SOLUBILITY OF CHLORINE IN HYDROCHLORIC ACID SOLUTIONS

Results at 20°
(Oliveri-Mandela, 1920)

The manner in which the results are reported is not perfectly clear. The solubility of chlorine in water is stated as 6.745 and 6.760 percent Cl. These figures are evidently grams per liter and not grams per 100 grams sat. solution.

(Total pressure = 760.5 mm)

Gm. mola. per liter

HC1 Cl₂

0.00	0.0965
1.155	0.1010
1.872	0.1049
2.500	0.1092
3.000	0.1139
4.101	0.1243

Results at 25°
(Sherrill and Isard, 1928, 1931)

The chlorine, prepared by the action of HCl on chromic acid was bubbled through the solution in an absorption train which was painted black to prevent decomposition of chlorine by light.

Moles per
1000 gms. H₂O

Molea per
1000 gms. H₂O

0.00	0.0923	3.989	0.0914
0.010	0.08264	4.903	0.0978
0.100	0.06394	5.180	0.1004
0.200	0.0619	7.016	0.1150
0.496	0.0630	8.163	0.1219
1.019	0.0665	8.854	0.1281
1.991	0.0737	9.805	0.1326
2.990	0.0824		

Cl CHLORINE

Results at 21°
(Mellor, 1901)

[In agreement with those of Oliveri-Mandala, 1920]

α = Ml Cl_2 (S.T.P.) per ml sat. sol. when p.p. Cl_2 = 1 atm.

l = Ml Cl_2 (21°, 1 atm.) per ml sat. sol. when p.p. Cl_2 = 1 atm.

Gms. per liter			
HCl	Cl_2	α	l
0.0	7.23	2.1167	2.2799
3.134	5.30	1.5496	1.6698
6.248	4.94	1.4483	1.5607
9.402	4.76	1.3942	1.5013
12.540	4.85	1.4200	1.5292
15.670	5.10	1.4933	1.6092
31.340	5.81	1.6736	1.8033
62.680	6.38a	1.8682	2.0131
94.020	7.19b	2.1044	2.2677
125.306	7.76b	2.2711	2.4473
156.700	8.58c	2.5095	2.7043
188.040	9.23c	2.7020	2.9117
219.380	9.93	2.9243	3.1312
250.720	10.68	3.1277	3.3677
282.060	11.87	3.3278	3.5859
313.401	12.03	3.5492	3.8224

a at 20°

b at 20.5°

c at 20.2°

Results at Several Temperatures
(Goodwin, 1882)

These data are higher than those of later workers, but may serve to show the change in solubility with temperature.

"Coefficient of Solubility" (1)

t°	9.2%	16.0%	24.2%
	HCl	HCl	HCl
	(Sp. Gr. 1.046)	(Sp. Gr. 1.080)	(Sp. Gr. 1.125)
0	4.1	6.4	7.3
5	5.1	5.2	6.7
10	4.1	4.5	6.1
15	3.5	3.9	5.5
20	3.0	3.4	4.7
25	2.5	3.0	4.0
30	2.0	2.4	...
40	1.25	1.6	...

SOLUBILITY OF CHLORINE IN AQUEOUS SULFURIC AND ACETIC ACIDS

In aq. H_2SO_4 at 25°
(Sherrill and Izard, 1931)

In aq. $\text{HC}_2\text{H}_3\text{O}_2$ at 15°
(Jones, 1911)

Moles per 1000 gms. H_2O		Vol. % $\text{HC}_2\text{H}_3\text{O}_2$	"Coefficient of Solubility" (1)
H_2SO_4	Cl_2		
0.4995	0.06272	65	13.43
1.0240	0.05617	75	16.43
1.9686	0.04973	90	25.3
3.0090	0.04550	99.84	36.7
3.9934	0.04278		
4.9901	0.04066		

SOLUBILITY OF CHLORINE IN AQUEOUS SODIUM CHLORIDE SOLUTIONS

Results at 20°
(Oliveri-Mandala, 1920)

Results at 25°
(Sherrill and Izard, 1931)

The results for chlorine are stated to be in terms of gm. mola per liter when it is evident that they are really gms. per liter. Correcting these apparent errors, the results are as follows:

(762 mm. Total Pressure)

Gm. mols. per liter		Moles per 1000 gms. H_2O	
NaCl	Cl_2	NaCl	Cl_2
0.000	0.0953	0.501	0.06575
0.777	0.0705	0.998	0.05795
1.323	0.0594	2.991	0.04161
1.965	0.0496	3.989	0.03601
3.159	0.0373	4.989	0.03087
3.597	0.0321		

Results at several temperatures:
(Kumpf, 1882; Kohn and O'Brien, 1898)

Coefficient of Solubility (1) in:

t°	9.97% NaCl	16.01% NaCl	19.66% NaCl	26.39% NaCl
0	2.3	1.9	1.7	0.5
5	2.0	1.6	1.4	0.44
10	1.7	1.3	1.15	0.4
15	1.4	1.06	0.95	0.36
20	1.2	0.9	0.8	0.34
25	0.94	0.75	0.65	0.3
50	...	...	...	0.2
80	...	...	...	0.05

Cl CHLORINE

SOLUBILITY OF CHLORINE IN AQUEOUS SOLUTIONS OF SEVERAL SALTS

Data of Sherrill and Isard, 1931 at 25°				Results of Goodwin, 1882 at several temperatures	
Barium Chloride		Potassium Chloride		t°	Coefficient of Solubility (l) in KCl aq. (20 g KCl per 100 cc)
Gm. mols. per 1000 gms. H ₂ O		Gm. mols. per 1000 gms. H ₂ O			
BaCl ₂	Cl ₂	KCl	Cl ₂		
				0	1.5
				5	2.0
0.330	0.06216	0.500	0.06610	10	2.2
0.667	0.05494	1.000	0.06109	15	1.6
1.000	0.04924	2.013	0.05388	20	1.2
1.333	0.04468	3.014	0.04865	25	1.0
		3.913	0.04724	30	0.9

100 cc of 6.2 per cent CaCl₂ solution dissolve 0.245 gm. Cl at 12°.

100 cc of 6.2 per cent MgCl₂ solution dissolve 0.233 gm. Cl at 12°.

100 cc of 6.2 per cent MnCl₂ solution dissolve 0.200 gm. Cl at 12°.

Goodwin (1882) gives results for solutions of NaCl, CsCl₂, MgCl₂, SrCl₂, Fe₂Cl₂, CoCl₂, NiCl₂, MnCl₂, CdCl₂, LiCl, and in mixtures of some of these, but the concentrations of the salt solutions are not stated.

SOLUBILITY OF CHLORINE IN CARBON TETRACHLORIDE (Taylor and Hildebrand, 1923; Smith, 1955)

t°	Moles Cl ₂ per Kg. sat. sol. per atm. Cl ₂	Mole % Cl ₂ in sat. sol. at 1 atm. pp. Cl ₂	t°	Moles Cl ₂ per Kg. sat. sol. per atm. Cl ₂
0	2.23	29.8 (T and H)	60	0.522
19	1.30	18.7 (T and H)	70	0.425
40	0.809	12.15 (T and H)	80	0.335
	0.793 (S)	-	90	0.296
50	0.596 (S)	-		

Additional data for the solubility in CCl₄ are given by Jakowkin, 1899; Perkin, 1894; Jones 1911 and Schwab and Hautke, 1924.

DISTRIBUTION OF CHLORINE BETWEEN CARBON TETRACHLORIDE AND WATER AT 0° (Jakowkin, 1899)

Data for the effect of HCl upon the distribution between H₂O and CCl₄ are also given.

Millimols per Liter			Millimols per Liter		
H ₂ O Layer		CCl ₄ Layer	H ₂ O Layer		CCl ₄ Layer
Total Cl	Unhydrolyzed Cl		Total Cl	Unhydrolyzed Cl	
61.73	42.55	864.2	23.08	11.12	222.5
58.21	39.67	803.3	21.70	9.94	202.7
38.36	22.07	464.6	10.10	2.707	52.93
28.98	15.24	311.3			

SOLUBILITY OF CHLORINE IN OTHER SOLVENTS

Solvent	t°	Solubility at 1 atm. pp. Cl ₂	Author
Acetic anhydride	15	Solubility coeff. (1) = 39.6	(Jones, 1911)
Dimethyl formamide	0	385 vol. per vol. solvent	(DuPont, 1955)
Ethylene dibromide	20	19.2 mole % Cl ₂ in sat. sol.	(Taylor and Hildebrand, 1923)
	40	11.9 mole % " " " "	{ " " " " }
n-Heptane	0	27.0 mole % " " " "	{ " " " " }
Silicon Tetrachloride	0	28.8 mole % " " " "	{ " " " " }
n-perfluoroheptane	0	1614 mcle % " " " " ($\alpha = 20.1$)	(Gjaldbaek and Hildebrand, 1950)
	15.8	11.7 mole % " " " "	{ " " " " }
	20	11.0 mole % " " " " ($\alpha = 12.3$)	{ " " " " }
	22	10.5 mole % " " " "	{ " " " " }
	25	9.8 mole % " " " " ($\alpha = 10.7$)	{ " " " " }

pp. Cl₂ (Atm.) Mole % Cl₂ in sat. sol.

Titanium tetrachloride 20°	1.50	25.13	(Krievé and Mason, 1956)
	2.20	35.85	
	2.71	43.58	
	3.13	49.64	
	3.67	56.74	
	4.24	64.99	
30°	4.76	72.29	
	3.39	42.27	
	3.93	48.44	
	4.63	55.71	
	5.41	64.12	
	6.14	71.07	

Freezing-point data are given for mixtures of chlorine and the following compounds:

Carbon tetrachloride (1) (14) (5)	Titanium tetrachloride (5)
Chloroform (1) (2) (13)	Sulfur (9) (15)
Methyl Alcohol (1) (2)	Sulfur Dioxide (10) (11)
Ethyl Alcohol (1) (2)	" " + Sulfuryl Chloride (11)
Methyl Acetate (2)	Sulfuryl Chloride (11)
Ethyl Acetate (1) (2) (3)	Stannic Chloride (2)
Acetone (1) (3)	Toluene (2) (3)
Ethyl Ether (1) (2)	Nitrosyl Chloride (6) (12)
Hydrogen Chloride (3)	Phosphorus oxy tri Chloride (16)
Iodine (8)	Ethylene Oxide (4)
Tin tetrachloride (1) (5)	Tellurium (7)
Silicon tetrachloride (5)	Methyl Chloride (17)
	Methylene dichloride (17)

(1) Waentig and McIntosh, 1915; (2) Waentig and McIntosh, 1916; (3) Maas and McIntosh, 1912; (4) Maas and Boomer, 1922; (5) Biltz and Meinecke, 1923; (6) Trantz and Gerwig, 1925; (7) Damiens, 1923; (8) Stortenbecker, 1888, 1889; (9) Ruff and Fischer, 1903; (10) Smits and Moev, 1910; (11) Vander Goot, 1913; (12) Boubnoff and Guey, 1911; Wheat II and Browne, 1936; (14) Wheat II and Browne, 1938; (15) Lowry, McHatton and Jones, 1927; (16) Rollet and Graf, 1933; (17) Wheat and Browne, 1940.

Cl CHLORINE

0 CHLORINE MONOXIDE Cl₂O

THE SYSTEM CHLORINE MONOXIDE - WATER BELOW 0° (Secoy and Cady, 1940)

The system is characterized by a liquid immiscibility gap, but the work was not attempted above 270° (K°) because of the decomposition and high vapor pressure at higher temperatures. The temperatures were measured with a copper - constantan thermocouple, and are reported in Kelvin degrees.

Temp. °K	Mole % Cl ₂ O	Solid Phase	Solubility of Cl ₂ O in H ₂ O	
			Temp. °K	Mole % Cl ₂ O
267.2	2.7	Ice		
264.4	3.9	"		
259.4	5.9	"	263.8	22.9
253.5	7.9	"	259.9	22.1
251.0	8.4	"	257.3	21.7
245.1	10.0	"	251.1	20.6
242.5	10.6	"	247.4	20.1
233.5	11.7	Ice + HOCl·2H ₂ O	246.4	20.0
234.2	11.9	HOCl·2H ₂ O	244.2	20.3
234.5	12.0	"	241.2	20.4
235.3	12.5	"	240.0	20.5
235.8	13.1	"	238.4	20.6
236.3	13.7	"	236.8	20.7
236.6	14.4	"		
236.8	15.1	"		
236.9	15.4	"	Solubility of H ₂ O in Cl ₂ O	
237.0	16.1	"		
237.1	16.6	"	Temp. °K	Mole % H ₂ O
237.1	17.5	"		
237.0	18.7	"	270.0	3.4
236.9	19.5	"	236.8	2.9
236.8	20.7	HOCl·2H ₂ O (+ 2 liquids)	194.6	1.8
152.6	100.0	Cl ₂ O		

SOLUBILITY OF CHLORINE MONOXIDE IN WATER ABOVE 0° (Secoy and Cady, 1941)

The authors calculated the heat of solution at each temperature and found that it nearly doubled over a 13° range of temperature. Because this seems unlikely, they regard their data as only tentative. The assumption was made that no HOCl or Hydrates of Cl₂O existed in the vapor phase. The data are in terms of gms. Cl₂O per 100 gms. H₂O:

Pressure Cl ₂ O	Temperature		
mm	0°	10°	20°
1	7.6	5.2	3.5
5	16.7	12.3	8.0
10	23.7	17.4	11.1
20	33.6	24.2	15.4
30	40.7	29.2	18.7
40	46.9	33.0	21.3
50	52.4	36.2	23.7
60	56.7	39.0	25.8
70	60.2	41.4	27.7
75	61.6	42.5	28.6

A nomograph has been prepared from the above results by Davis (1942).

CHLORINE DIOXIDE $\text{ClO}_2 \cdot 8\text{H}_2\text{O} \pm 1\text{H}_2\text{O}$

0

SOLUBILITY IN WATER
(Bray, 1905-06)

t°	Gms. ClO_2 per Liter	Solid Phase
- 0.79 Eutec.	26.98	$\text{ClO}_2 \cdot 8\text{H}_2\text{O} + \text{Ice}$
0	27.59	$\text{ClO}_2 \cdot 8\text{H}_2\text{O} \pm 1\text{H}_2\text{O}$
1	29.48	"
5.7	42.10	"
10	60.05	"
15.3	87.04	"
10.7 tr. pt.	107.9	" + liquid ClO_2
14	more than > 107.9	liquid ClO_2
10.7	116.7	"
1	more than > 108.6	"

The exact composition of the hydrate could not be determined on account of manipulative difficulties.

Data for the distribution of ClO_2 between H_2O and CCl_4 at 0° and 25° are given, also some results showing the effect of H_2SO_4 , KClO_3 and of KCl on this distribution.

CHLORINE TRIOXIDE Cl_2O_3

0

SOLUBILITY IN WATER AT APPROX. 760 mm. PRESSURE
(Brandan, 1869)

t°	8.5°	14°	21°	93°
Gms. Cl_2O_3 per 100 gms. H_2O	4.785	5.012	5.445	5.651

Garzarolli and Thurnbalk, 1881, say that Cl_2O_3 does not exist, and above figures are for mixtures of Cl_2O and Cl .

CURIUM Cm

CURIUM FLUORIDE

F

CURIUM HYDROXIDE

OH

The apparent solubility of curium fluoride is about 20 micrograms per ml. That of curium hydroxide is about 10 micrograms per ml.
(Werner and Perlman, 1951)

Co COBALT

COBAL Co

The solubility of cobalt in mercury was found by Tammann and Kollmann, 1927, by a potentiometric method, to be 0.2×10^{-5} gm. mol. Co per gm. mol. Hg (= 0.00059 gm. Co per 100 gm. Hg) at 17°. Using cobalt amalgam prepared by electrolysis, Irvin and Russel, 1932, found for the upper limit of solubility only 0.00008 gm. Co per 100 gm. Hg.

Melting point data are given for:

Co + S (1) (3)	Co + CoS (2)	Co + Bi + S (3)
Co + O (1)	Co + CoS + FeS (2)	Co + Sb + S (3)

(1) Asanti and Kohlmeier, 1951 (2) Vogel and Hillner, 1953

(3) Schenck and Von der Forst, 1952

Br COBALT BROMIDE CoBr_2

SOLUBILITY OF COBALT BROMIDE IN WATER (Benrath and Schiffers, 1938)

t°	Gms. CoBr_2 per 100 gms.			Solid Phase	t°	Gms. CoBr_2 per 100 gms.			Solid Phase
	sat.	sol.	H_2O			sat.	sol.	H_2O	
0	47.9	91.9		$\text{CoBr}_2 \cdot 6\text{H}_2\text{O}$	50	66.8	201.2		$\text{CoBr}_2 \cdot 4\text{H}_2\text{O}$
25	54.4	119.1		"	55	68.3	215.4		"
38	59.8	148.5		"	60	69.4	226.3		" + $\text{CoBr}_2 \cdot 2\text{H}_2\text{O}$
40	60.9	155.6		"	61	69.6	228.2		$\text{CoBr}_2 \cdot 2\text{H}_2\text{O}$
42	64.2	179.0		"	63	69.8	231		"
43	65.2	187.5		" + $\text{CoBr}_2 \cdot 4\text{H}_2\text{O}$	75	70.3	237.0		"
47	66.4	197.5		$\text{CoBr}_2 \cdot 4\text{H}_2\text{O}$	100	72.0	257.0		"

EQUILIBRIUM IN THE SYSTEM COBALT BROMIDE - AMMONIUM BROMIDE - AND WATER AT VARIOUS TEMPERATURES (Benrath and Schiffers, 1938)

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	CoBr_2	$(\text{NH}_4)\text{Br}$			CoBr_2	$(\text{NH}_4)\text{Br}$	
0	45.0	5.8	$\text{Co}_6 + \text{NH}_4\text{Br}$	25	10.76	33.6	NH_4Br
"	36.0	9.3	NH_4Br	"	6.30	37.9	"
"	28.5	14.1	"	"	2.45	41.7	"
25	53.4	2.63	Co_6	38	50.0	11.4	$\text{Co}_6 + \text{NH}_4\text{Br}$
"	52.6	4.90	"	40	58.3	3.82	Co_6
"	47.8	9.08	" + NH_4Br	"	50.2	11.52	" + NH_4Br
"	44.6	10.05	NH_4Br	"	31.6	19.49	NH_4Br
"	37.7	13.24	"	"	15.74	32.6	"
"	25.0	21.4	"	"	2.53	45.0	"

$\text{Co}_6 = \text{CoBr}_2 \cdot 6\text{H}_2\text{O}$; $\text{Co}_2 = \text{CoBr}_2 \cdot 2\text{H}_2\text{O}$; $1.2.2 = \text{CoBr}_2 \cdot 2\text{NH}_4\text{Br} \cdot 2\text{H}_2\text{O}$

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase	
	CoBr ₂	(NH ₄)Br			CoBr ₂	(NH ₄)Br		
42	62.7	7.60	Co6 + Co4 + 1.1.2	55	18.22	32.8	NH ₄ Br	
"	63.2	3.92	Co4	"	9.01	41.5	"	
47	65.4	2.45	"	"	3.85	46.7	"	
"	63.6	8.20	" + 1.2.2	75	68.9	3.06	Co2	
"	63.0	8.7	1.2.2	"	64.8	12.86	" + 1.2.2	
"	54.8	12.25	"	"	62.4	13.25	1.2.2	
50	62.2	9.8	"	"	50.3	21.0	" + NH ₄ Br	
55	68.2	1.96	Co4	"	31.3	27.5	NH ₄ Br	
"	67.5	2.60	"	"	19.19	41.8	"	Br
"	67.1	3.55	"	"	3.25	51.2	"	
"	66.2	6.86	" + Co2	100	69.8	5.40	Co2	
"	65.6	8.95	1.2.2 + Co2	"	65.8	14.4	" + 1.2.2	
"	64.6	9.40	" + "	"	61.9	17.4	1.2.2	
"	51.9	16.08	" + NH ₄ Br	"	41.0	34.5	" + NH ₄ Br	
"	50.2	16.0	NH ₄ Br	"	23.3	40.9	NH ₄ Br	
"	37.1	19.0	"	"	9.88	50.4	"	
"	27.7	25.1	"					

Co6 = CoBr₂·6H₂O; Co2 = CoBr₂·2H₂O; 1.2.2 = CoBr₂·2NH₄Br·2H₂O

SOLUBILITY OF COBALT BROMIDE IN METHYL ALCOHOL AND IN ETHYL ALCOHOL
(Lloyd, Brown, Glynn, Bonnell, and Jones, 1928)

Results for Methyl Alcohol			Results for Ethyl Alcohol		
t°	Gms. CoBr ₂ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. CoBr ₂ per 100 gms. CH ₃ OH	Solid Phase
20	43.0	CoBr ₂ ·6CH ₃ OH	10	70.6	CoCl ₂ ·3C ₂ H ₅ OH
30	58.6	"	20	77.1	"
35	80.0	"	30	84.9	"
37	94.3	"	40	95.9	"
40	124.8	CoBr ₂ ·3CH ₃ OH	50	105.0	"
50	141.9	" (?)	60	120.8	"
60	153.1	CoBr ₂ ·2CH ₃ OH	70	127.1	CoCl ₂ ·2C ₂ H ₅ OH
70	169.0	"	80	129.4	"
80	190.6	"			

SOLUBILITY OF COBALT BROMIDE IN ABSOLUTE ACETONE
(Bell, Rowlands, Bamford, Thomas and Jones, 1930)

t°	Gms. CoBr ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase	t°	Gms. CoBr ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase
0	54.1	CoBr ₂ ·C ₃ H ₆ O	27	68.7	CoBr ₂ ·C ₃ H ₆ O
10	54.3	"	30	69.6	"
25	65.0	"	40	92.4	"

Co COBALT

SOLUBILITY OF CoBr_2 IN METHYL ACETATE

100 gms. methyl acetate ($d_{18} = 0.935$) dissolve 10.3 gms. CoBr_2 at 18° , d_{18} of sat. solution = 1.013. (Naumann, 1909)

CH COBALT ACETATE $\text{Co}(\text{CH}_3\text{COO})_2$

100 gms. methyl alcohol dissolve 1.49 gm. $\text{Co}(\text{CH}_3\text{COO})_2$ at 15° and 5.50 gms. at 66.4° (b. pt.). (Henstock, 1934)

100 cc anhydrous hydrazine dissolve 1.0 gm. cobalt acetate with evolution of gas at room temp. (Welsh and Broderson, 1915)

0.02 gms. $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2$ are dissolved in one liter of a saturated solution in Furfural at 25° ; 0.01 gms. $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$ dissolve under the same conditions (Trimble, 1941).

COBALT TRIFLUORO ACETATE $\text{Co}(\text{CF}_3\text{COO})_2$

16.65 gms. $\text{Co}(\text{CF}_3\text{COO})_2$ dissolve in 100 gms. anhydrous CF_3COOH at 29.8° . The solid phase is $\text{Co}(\text{CF}_3\text{COO})_2 \cdot 2\text{CF}_3\text{COOH}$. (Hara and Cady, 1954)

COBALT METHIONATE $\text{CoCH}_2\text{O}_6\text{S}_2 \cdot 5\text{H}_2\text{O}$

100 gms. H_2O dissolve 120.3 gms. $\text{CoCH}_2\text{O}_6\text{S}_2$ at 25° . (Baker and Terpstra, 1929)

COBALT RUBEAMATE $[\text{Co}(\text{HHSCCSMH})?]$

The Ksp is 1.2×10^{-15} . The salt is about 10 times as soluble in 0.01N NH_3 as in water. (Malyuga, 1955)

CH COBALT FUMARATE $\text{CoC}_4\text{H}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$

100 gms. H_2O dissolve 0.88 gm. $\text{CoC}_4\text{H}_2\text{O}_4$ at 30° . (Weiss and Downs, 1923)

COBALT MALATE $\text{Co}(\text{COO} \cdot \text{CH}_2 \cdot \text{CHOHCOO}) \cdot 2\text{H}_2\text{O}$

100 cc sat. solution in water contain 0.14 gm. Co = 0.453 gm. anhydrous salt at 10° .

COBALT MALONATES

CH

SOLUBILITY OF COBALT MALONATES IN WATER
(Lord, 1907)

Salt	Formula	t°	Gms. Anhydrous Salt per 100 Gms. sat. sol.
Cobalt Malonate	$\text{CoCH}_2(\text{COO})_2 \cdot 2\text{H}_2\text{O}$	18	1.353
" Ammonium Malonate	$\text{Co}(\text{NH}_4)_2[\text{CH}_2(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	10.61
" Cesium "	$\text{CoCs}_2[\text{CH}_2(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	14.23
" Potassium "	$\text{CoK}_2[\text{CH}_2(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	4.26

COBALT CITRATES

SOLUBILITY IN WATER
(Pickering, 1915)

Salt	Formula	t°	Gms. per 100 cc sat. sol. Salt Co = (anhy- drous)
Cobalt Citrate (normal)	$\text{Co}_3[(\text{COO} \cdot \text{CH}_2)_2\text{C}(\text{OH})\text{COO}]_2 \cdot 2\text{H}_2\text{O}$	10	0.08 0.267
Cobalt Hydrogen Citrate	$\text{CoH}[(\text{COO} \cdot \text{CH}_2)_2\text{C}(\text{OH})\text{COO}]_2$	10	0.20 0.906
Cobalt Potassium Citrate	$\text{KCo}[(\text{COO} \cdot \text{CH}_2)_2\text{C}(\text{OH})\text{COO}]_2 \cdot 4\text{H}_2\text{O}$	10	1.05 5.11
Cobalt Potassium Citrate	$\text{K}_4\text{Co}[(\text{COO} \cdot \text{CH}_2)_2\text{C}(\text{OH})\text{COO}]_2$	10	3.04 31

COBALT PYRIDINE - RHODINATE $\text{C}_5\text{H}_5\text{NCoCNS}$ (?)

0.00373 mols. are dissolved in one liter of a saturated solution in water. 0.0117 mols. are dissolved in one liter of a saturated solution in Absolute Alcohol (probably at 20°). Treadwell and Ammann, 1938.

COBALT ANTHRANILATE $\text{Co}(\text{H}_2\text{NC}_6\text{H}_4\text{COO})_2$

CH

0.00412 mols. are dissolved in one liter of a saturated solution in water which is IN with acetic acid (probably at 20°). Treadwell and Ammann, 1938.

COBALT Nitroso phenyl HYDROXYLAMINE (Cupferrate) $\text{Co}(\text{C}_6\text{H}_5\text{N}(\text{HO})\text{O})_2$

One liter sat. solution in water contains 0.0013 gm. atoms Co (=0.077 gm. Co) at 18°. (Pinkus and Martin, 1927)

Co COBALT

0.0107 mols. are dissolved in one liter of a saturated solution in water which is 0.01 N with acetic acid (probably at 20°). Treadwell and Ammann, 1938.

CH COBALT BENZOATE, CHLORO BENZOATE, etc. COBALT CINNAMATE

SOLUBILITY OF EACH IN WATER AT 20°
(Ephraim and Pfister, 1923)

Compound	Formula	Gms. anhydrous compound per 100 cc sat. sol.
Cobalt benzoate	$(C_6H_5COO)_2Co \cdot 4H_2O$	1.013
" -4-chloro benzoate	$(C_6H_4 \cdot Cl \cdot COO)_2Co \cdot 4H_2O$	1.720
" -4-methoxy "	$(C_6H_4 \cdot OCH_3 \cdot COO)_2Co \cdot 3H_2O$	0.9934
" -4-nitro "	$(C_6H_4 \cdot NO_2 \cdot COO)_2Co \cdot 6H_2O$	0.893
" -4-oxy "	$(C_6H_4 \cdot OH \cdot COO)_2Co \cdot 7H_2O$	1.254
" cinnamate	$C_{18}H_{14}O_4Co \cdot 2H_2O$	0.302

CH COBALT SULFONATES (aromatic)

SOLUBILITY OF COBALT BENZENE SULFONATE IN WATER
(Ephraim and Seger, 1925; Ephraim and Pfister, 1925)

t°	17°	20°	36°	50°	65°	80.5°
Gms. $(C_6H_5SO_3)_2Co^*$ per 100 cc sat. sol. }	7.535	7.778	11.086	14.144	19.717	26.735

*Solid phase is hexahydrated.

SOLUBILITY OF SEVERAL COBALT SULFONATES IN WATER
(Ephraim and Pfister, 1925)

Compound	Formula	Gms. anhydrous cmpd. per 100 t° cc sat. sol.
Cobalt anthracene-1-sulfonate	$(C_{11}H_9SO_3)_2Co \cdot 6H_2O$	20 0.391
" " -2- "	$(C_{11}H_9SO_3)_2Co \cdot 6H_2O$	20 0.00519
" naphthalene-1- "	$(C_{10}H_7SO_3)_2Co \cdot 6H_2O$	17 6.417
" " -2- "	$(C_{10}H_7SO_3)_2Co \cdot 6H_2O$	20 0.209
" " " "	" "	32 0.312
" " " "	" "	45 0.455
" " " "	" "	59 0.737
" " " "	" "	74 1.216
" " " "	" "	82 1.568
" " -5-Chlor-1-Sulfonate	$(C_{10}H_6SO_3)_2Co \cdot 4H_2O$	20 0.709
" " -6-Oxy-2	$(C_{10}H_7SO_3)_2Co \cdot 8H_2O$	20 0.500
" 2.6.8 naphthylamine disulfonate	$(C_{10}H_9NH_2 \cdot SO_3)_2Co$	15 27.96 *
" 2.5.7 " "	" "	" 29.4 *

*These determinations are by Braunschweig 1922, 1926; and refer to grams per 100 gms. of the sat. solution instead of gms. per 100 cc sat solution.

SOLUBILITY OF XYLOL SULFONATE AND SELENATES IN WATER
(Anschutz, Kallen and Riepenkröger, 1919)

Compound	Formula	t°	Gms. anhydrous compd. per 100 gms. H ₂ O
Cobalt ortho xylol selenate	$[(CH_3)_2 \cdot 1 \cdot 2 \cdot C_6H_3 \cdot 4 \cdot SeO_3]_2 Co \cdot 5H_2O$	18°	0.66
" para " "	$[(CH_3)_2 \cdot 1 \cdot 4 \cdot C_6H_3 \cdot 4 \cdot SeO_3]_2 Co \cdot 9H_2O$	15°	1.38
" ortho " sulfonate	$[(CH_3)_2 \cdot 1 \cdot 2 \cdot C_6H_3 \cdot 4 \cdot SO_3]_2 Co \cdot 5H_2O$	16°	2.10

COBALT HELIANTHATE $Co(C_{14}H_{14}N_3SO_3) \cdot 4H_2O$

CH

1000 cc H₂O dissolve 0.036 gm. of the hydrated salt at 20-25°. (Stark and Dehn, 1918)

COBALT QUINOLINE DERIVATES (oxine, etc.)

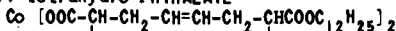
The Ksp of cobalt 8-hydroxy quinolate is 2.5×10^{-22} at room temperature. The Ksp of the 2-methyl-8-hydroxy quinolate is 1.4×10^{-22} . (Borrel and Paris, 1952)

Extraction of the 8-hydroxy quinolate by CHCl₃ from water solution is "complete" above pH 6.8. (Moeller, 1943)

Ksp data for the cobalt salts of 8-, 2-, and 6-quinoline carboxylic acids are given by Lumme, 1955.

COBALT dodecyl tetrahydro PHTHALATE

CH



At 25° up to 1.5% by weight will dissolve in acid-washed kerosene. (White, 1949)

COBALT CYANIDE $Co(CN)_2$

CN

One liter sat. solution of cobalt cyanide in water contains 3.77×10^{-4} gm. mols. $Co(CN)_2$ at 18° determined by the potentiometric method (Masaki, 1931)

COBALT FERROCYANIDE $Co_2Fe(CN)_6$

A saturated solution in water contains 2.4×10^{-5} gms. ions Co^{++} per liter. (Tananaev, Glushkova, and Seifer, 1956)

Co COBALT

Data on the precipitation of $\text{Co}_2\text{Fe}(\text{CN})_6$ and $3\text{Co}_2\text{Fe}(\text{CN})_6 \cdot \text{M}_4\text{Fe}(\text{CN})_6$ ($\text{M} = \text{Na}, \text{Cs}$) from solutions of $\text{CoSO}_4 + \text{M}_4\text{Fe}(\text{CN})_6$ ($\text{M} = \text{Na}, \text{Cs}, \text{Li}$) are given by Tananaev and Levina, 1949.

COBALT NITROPRUSSIATE $\text{CoFe}(\text{CN})_5 \cdot \text{NO} \cdot 4\frac{1}{2}\text{H}_2\text{O}$

One liter sat. solution of cobalt nitroprussiate in water contains 2.0×10^{-4} gm. mols. $\text{CoFe}(\text{CN})_5 \cdot \text{NO}$ at 20° . (Tomicek and Kubik, 1937)

SCN COBALT THIOCYANATE $\text{Co}(\text{SCN})_2$

One liter sat. solution of cobalt thiocyanate in water contains 0.341 gm. mols. $\text{Co}(\text{SCN})_2$ at 18° (≈ 59.71 gms. $\text{Co}(\text{SCN})_2$) determined by the potentiometric method. (Masaki, 1931)

100 gms. sat. solution in water contain 50.7 gms. $\text{Co}(\text{SCN})_2$ at 25° . (de Sweemer, 1932)

Data for equilibrium in the systems $\text{Co}(\text{SCN})_2 + \text{KSCN} + \text{H}_2\text{O}$ and $\text{Co}(\text{SCN})_2 + \text{Ni}(\text{SCN})_2 + \text{H}_2\text{O}$ at 25° are also given by de Sweemer, 1932.

The extraction of $\text{Co}(\text{SCN})_2$ from aqueous solutions by ether, ether + amyl alcohol and amyl acetate has been studied by Skey (1867), von Grossman (1930), Rosenheim and Huldshinsky (1901), Vogel (1879), Treadwell (1901) and Weber (1930). Results for the distribution of $\text{Co}(\text{SCN})_2$ between NH_4SCN solutions and butyl acetate at 0, 16 and 26° are given by Leveshova, Darienko and Degtyarev, 1955.

THE SYSTEM COBALT THIOCYANATE - METHYL THIOCYANATE (Gillis and Sweemer, 1934)

t°	% $\text{Co}(\text{CNS})_2$	Solid Phase
-53.55	0.0	CH_3CNS
-53.8	6.6	"
-54.5	10.8	"
-54.8	12.8	"
-57.2	18.0	"
-58	19.0	"
-60	21.5	"
-59.2	19.9	"
-59.8	20.8	"
-61.2	21.9	$\text{CH}_3\text{CNS} + 2\text{CH}_3\text{CNS} \cdot \text{Co}(\text{CNS})_2$
0	22.17	$2\text{CH}_3\text{CNS} \cdot \text{Co}(\text{CNS})_2$
25	23.4	"
35	25.2	"
37	27.3	"
38	-	$2\text{CH}_3\text{CNS} \cdot \text{Co}(\text{CNS})_2 + \text{Co}(\text{CNS})_2$
39	28.0	$\text{Co}(\text{CNS})_2$
41	28.8	"
45	28.1	"
50	28.2	"
55	28.2	"
65	28.25	"
70	28.3	"

SOLUBILITY OF $\text{Co}(\text{SCN})_2$ IN LIQUID SO_2

100 gms. liquid sulfur dioxide dissolve 0.076 gm. $\text{Co}(\text{SCN})_2$ at 0° .
(Jander and Ruppolt, 1937)

COBALT MERCURY THIOCYANATE $\text{CoHg}(\text{SCN})_4$

CNS

SOLUBILITY OF COBALT MERCURY THIOCYANATE IN AQUEOUS
SOLUTIONS OF AMMONIUM CHLORIDE
(Cuveller, 1936)

Weighed amounts of $\text{CoHg}(\text{SCN})_4$ and measured volumes of standardized solutions of ammonium chloride were rotated in sealed tubes at a very gradually rising temperature and the point noted at which the last trace of solid just disappeared. The determinations can be made only with very finely divided $\text{CoHg}(\text{SCN})_2$.

Normality of NH_4Cl	Gms. $\text{CoHg}(\text{SCN})_2$ per 100 gms. sat. sol.	t° of solution	Normality of NH_4Cl	Gms. $\text{CoHg}(\text{SCN})_2$ per 100 gms. sat. sol.	t° of solution
0.02344	0.1851	58.1	0.3750	0.7964	65.7
"	0.2146	61.5	"	0.9301	71.3
"	0.2823	67.7	0.7500	0.5661	37.2
"	0.3247	71.8	"	0.6446	41.8
0.046875	0.2250	55.5	"	0.7645	48.9
"	0.2887	61.4	"	0.8854	55.4
"	0.3608	67.9	"	0.9945	60.4
"	0.4313	73.8	"	1.048	62.7
"	0.4587	76.1	"	1.186	67.8
0.09375	0.3210	56.7	1.50	0.7201	32.8
"	0.3407	58.5	"	0.8241	40.4
"	0.4376	65.8	"	1.136	52.5
"	0.4774	69.0	"	1.158	53.4
"	0.4895	69.9	"	1.189	54.3
0.1875	0.3874	54.2	"	1.340	59.4
"	0.4402	57.5	"	1.491	63.9
"	0.5083	62.1	3.00	1.203	39.4
"	0.5743	67.0	"	1.286	43.3
"	0.6048	68.9	"	1.472	50.7
0.3750	0.4576	45.3	"	1.579	54.2
"	0.5037	47.9	"	1.864	63.4
"	0.5774	52.6	"	2.108	69.4
"	0.6448	56.8	"	2.335	74.5
"	0.7392	62.8	"	2.654	79.8

The system $\text{CoHg}(\text{CNS})_4 + \text{ZnHg}(\text{CNS})_4$ was studied by Stahl and Straumanis, 1943, and Straumanis and Stahl, 1943.

Co COBALT

CO COBALT CARBONATE CoCO_3

SOLUBILITY IN WATER CONTAINING CARBON DIOXIDE (Smurov, 1938)

Partial Pressure CO_2 (Atm.)	Gms. Co per 100 gms. Saturated Solution				
	5	15	40	50	80
0.0005	0.0143	0.0109	0.0021	0.0013	0.0005
.005	.0335	.0256	.0050	.0031	.0013
.05	.0786	.0599	.0117	.0073	.0030
.10	.1016	.0775	.0151	.0094	.0039
Total Pressure $\text{CO}_2 + \text{H}_2\text{O} = 1 \text{ Atm.}$	.2382	.1816	.0354	.0220	.0091

COBALT Potassium CARBONATE $\text{CoK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$

Data for the solubility of this double salt in aqueous solutions of potassium carbonate and bicarbonate at 18° are given by Appleby and Lane, 1918. In the absence of KHCO_3 , basic compounds precipitate before attainment of equilibrium. Results are given for solutions containing an excess of KHCO_3 . The concentrations of cobalt were about 0.1 to 0.2 gm. per liter.

CO COBALT OXALATE $\text{CoC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

SOLUBILITY IN WATER

t°	Gms. per liter sat. sol.	Author
18	0.0211	Scholder, 1927; Scholder, Gadenne and Niemann, 1927
25	0.0211	Barney, Argersinger and Reynolds, 1951
25	0.0346	Ledrut and Hauss, 1932

SOLUBILITY IN FORMIC ACID SOLUTIONS

AT 25°

(Ledrut and Hauss, 1932)

Solvent	Gms. $\text{Co}(\text{COO})_2$ per liter sat. sol.
Water alone	0.0346
Aq. 25% HCOOH	0.0143
" 50% "	0.0158
" 75% "	0.0238
(" 95% ")	(0.4)*
" 100% "	0.0413

SOLUBILITY IN POTASSIUM OXALATE

SOLUTIONS AT 25°

(Barney, Argersinger and Reynolds, 1951)

Moles per liter	
$\text{K}_2\text{C}_2\text{O}_4$	CoC_2O_4
0.0	1.44×10^{-4}
4×10^{-4}	$9.2 \times 10^{-5} \dagger$
8×10^{-3}	2.1×10^{-4}

*Result of Aschan, 1913 at 19.8° .

\dagger Minimum in Soly. curve.

COBALT XANTHATE Co(SCSOM)_2 (?)SOLUBILITY OF COBALT XANTHATE IN ORGANIC SOLVENTS AT ROOM TEMPERATURE
(Kutzelnigg, 1948)

Solvent	Gms. Cobalt Xanthate per liter of Solvent	Solvent	Gms. Cobalt Xanthate per liter of Solvent
Lacquer Benzine	4	1:1 by volume	
Ethyl Alcohol	4	Benzene + Cyclohexanone	10
Iso Butyl Alcohol	2	9:1 by volume	
Acetone	21	Xylene + Dioxane	150
Methyl Glycol	24	Methylene Chloride	280
Benzene	200	Ethylene Trichloride	110
Xylene	32	Carbon Tetra Chloride	92
Toulene	150	Dioxane	124
Cyclohexanone	380	Carbon Disulfide	85

COBALT CHLORIDE CoCl_2

CI

SOLUBILITY OF COBALT CHLORIDE IN WATER

The fairly closely agreeing results of the following investigators were plotted on cross section paper and the table below constructed from the average curve so obtained; Benrath, 1934; Benrath, 1927; Bassett and Sanderson, 1932; Cuvelier, 1931; Foote, 1923, 1927; Mazzetti, 1926 and Osaka and Yaginuma, 1928. The earlier results of Etard, 1891, 1894, are probably in error.

t°	Gms. CoCl_2 per 100 gms. sat. sol.	Solid Phase	t°	Gms. CoCl_2 per 100 gms. sat. sol.	Solid Phase
0	30.3	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	55	47.6	$\text{CoCl}_2 \cdot 4\text{H}_2\text{O}$
10	32.3	"	58	48.4	" + $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$
20	34.6	"	60	48.4	$\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$
25	36.0	"	70	48.8	"
30	37.4	"	80	49.4	"
40	41.0	"	90	50.3	"
49	46.0	" + $\text{CoCl}_2 \cdot 4\text{H}_2\text{O}$	100	51.5	"
50	46.2	$\text{CoCl}_2 \cdot 4\text{H}_2\text{O}$			

Co COBALT

SOLUBILITY OF COBALT CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 25°
(Bassett and Harry, 1930)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	HCl		CoCl ₂	HCl	
Cl	35.87	0.0	CoCl ₂ ·6H ₂ O	17.84	24.50	CoCl ₂ ·2H ₂ O
	28.54	5.29	"	17.55	25.63	"
	22.78	9.34	"	17.90	28.08	"
	18.57	12.76	"	18.09	29.10	"
	14.05	17.66	"	18.37	29.95	"
	12.77	20.50	"	17.62	30.94	"
	13.10	21.09	"	18.32	31.37	"
	13.90	22.0	"	19.48	29.57	"
	15.50	22.51	"	20.14	31.06	"
	18.59	22.84	" + CoCl ₂ ·2H ₂ O	21.00	31.10	"
	18.18	23.45	CoCl ₂ ·6H ₂ O			

Results at 0°
(Foote, 1923)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	HCl		CoCl ₂	HCl	
	31.66	0.00	CoCl ₂ ·6H ₂ O	11.55	29.39*	CoCl ₂ ·6H ₂ O
	25.58	3.26	"	11.58	28.97	"
	17.78	8.74	"	12.42	29.14	"
	12.79	12.44	"	12.88	28.84	" + CoCl ₂ ·2H ₂ O
	5.97	19.01	"	12.66	30.27	"
	4.74	20.51	"	13.68	32.80*	CoCl ₂ ·2H ₂ O
	2.69	25.66	"	15.11	33.03	"
	2.07	27.27	"	15.12	33.86	"
	6.34	29.38	"	15.54	36.24*	"
	9.91	29.15	"	15.85	36.04*	"

*Bassett and Harry, 1930

Results below 0°
(Bassett and Harry, 1930)

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	HCl	
-20	12.52	42.78	CoCl ₂ ·2H ₂ O
-15	11.40	41.10	"

EQUILIBRIUM IN THE SYSTEM COBALT CHLORIDE - COBALT SULFATE - WATER
(Benrath and Ritter, 1939)

Gms. per 100 gms. Sat. Sol.			t°	Gms. per 100 gms. Sat. Sol.			t°	Gms. per 100 gms. Sat. Sol.			Solid Phase
CoCl ₂	CoSO ₄			CoCl ₂	CoSO ₄			CoCl ₂	CoSO ₄		
0	29.4	4.03	CoSO ₄ ·7H ₂ O+CoCl ₂ ·6H ₂ O	50	6.18	26.9	CoSO ₄ ·6H ₂ O				
	28.9	2.53	"		6.79	26.2	"				
	19.50	4.96	CoSO ₄ ·7H ₂ O		12.95	19.80	"				
	12.40	8.43	"		22.3	13.60	"				
	11.53	8.74	"		32.3	8.69	"				Cl
	3.13	16.00	"		32.9	9.36	CoSO ₄ ·6H ₂ O+CoSO ₄ ·H ₂ O				
Results of Langower, 1933 at 25°:			25		39.7	5.95	"				
					43.5	6.09	CoSO ₄ ·6H ₂ O+CoCl ₂ ·4H ₂ O				
	36.00	0.0	CoCl ₂ ·6H ₂ O		43.3	6.35	"				
	33.8	3.6	"		21.8	3.18	CoSO ₄ ·H ₂ O				
	32.8	4.6	" + CoSO ₄ ·7H ₂ O		34.9	5.18	"				
	26.8	6.1	CoSO ₄ ·7H ₂ O		35.7	6.65	CoSO ₄ ·6H ₂ O+CoSO ₄ ·H ₂ O				
	23.5	6.7	"		43.4	3.89	CoSO ₄ ·H ₂ O+CoCl ₂ ·4H ₂ O				
	20.3	9.6	"		45.0	2.80	CoCl ₂ ·4H ₂ O				
	15.5	11.3	"	51	43.9	3.89	CoSO ₄ ·H ₂ O+CoCl ₂ ·4H ₂ O				
	9.45	16.4	"	63.5	7.20	20.2	CoSO ₄ ·6H ₂ O+CoSO ₄ ·H ₂ O				
	5.6	20.1	"	75	1.35	34.5	CoSO ₄ ·H ₂ O				
	3.0	22.5	"		9.03	25.9	"				
	1.8	23.8	"		12.79	20.3	"				
	0.8	25.4	"		18.45	15.70	"				
	0.0	26.8	"		20.0	13.00	"				
					20.8	6.43	"				
					41.5	3.40	"				
38	37.4	3.70	CoCl ₂ ·6H ₂ O		43.1	2.53	"				
	36.4	4.70	CoCl ₂ ·6H ₂ O+CoSO ₄ ·6H ₂ O		50.2	2.18	CoCl ₂ ·2H ₂ O+CoSO ₄ ·H ₂ O				
	36.3	4.85	"		47.6	2.56	"				
	32.8	7.33	CoSO ₄ ·6H ₂ O		48.2	1.75	CoCl ₂ ·2H ₂ O				
	30.4	7.25	"	99.5	52.6	0.48	CoCl ₂ ·2H ₂ O+CoSO ₄ ·H ₂ O				
	28.2	7.52	"		50.8	1.82	"				
	25.4	9.25	"		49.2	4.30	"				
	21.8	10.56	"		39.0	2.37	CoSO ₄ ·H ₂ O				
	20.2	12.26	"		26.0	5.85	"				
	21.9	11.28	"		30.1	4.39	"				
	17.71	13.64	"		23.2	7.46	"				
	13.91	17.11	CoSO ₄ ·6H ₂ O+CoSO ₄ ·7H ₂ O		12.21	15.58	"				
	10.24	18.99	CoSO ₄ ·7H ₂ O		6.47	20.4	"				
	8.72	21.2	"		5.57	21.4	"				
	3.97	26.9	"		2.82	26.8	"				

Langower (1933) gives data for the system $\text{CoCl}_2 + \text{K}_2\text{SO}_4 \rightleftharpoons \text{CoSO}_4 + 2\text{KCl}$ in water at 25°.

Co COBALT

THE SYSTEM COBALT CHLORIDE - CESIUM CHLORIDE - WATER AT 25°
(Foote, 1927)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	CsCl		CoCl ₂	CsCl	
	35.67	0.0	CoCl ₂ ·6H ₂ O	12.76	32.6	1.2
	35.73	1.65	" + 1.1.2	10.42	37.63	"
	35.60	2.07	1.1.2	8.98	40.56	" + 1.3
	32.58	3.62	"	7.75	42.76	1.3
	30.82	6.12	"	0.45	64.50	"
Cl	31.09	5.03	" + 1.2	0.25	64.48	" + CsCl
	22.57	16.22	1.2	0.0	65.61	CsCl

1.1.2 = CoCl₂·CsCl·2H₂O; 1.2 = CoCl₂·2CsCl; 1.3 = CoCl₂·3CsCl.

Results for this same system, agreeing with the above, are given by Benrath, 1927.

THE SYSTEM COBALT CHLORIDE - CUPRIC CHLORIDE - WATER AT 25°
(Bassett, Henshall, Sergeant and Shipley, 1939)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CuCl ₂	CoCl ₂		CuCl ₂	CoCl ₂	
	0.0	35.87	CoCl ₂ ·6H ₂ O	25.62	17.48	CuCl ₂ ·2H ₂ O
	5.34	33.19	"	30.13	12.66	"
	9.99	30.50	"	34.00	8.99	"
	15.08	27.48	"	39.29	4.34	"
	18.01	26.06	" + CuCl ₂ ·2H ₂ O	44.00	0.0	"

THE SYSTEM COBALT CHLORIDE - FERRIC CHLORIDE - WATER AT 25°
(Osaka and Yaginuma, 1928)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	FeCl ₃		CoCl ₂	FeCl ₃	
	36.08	0.0	CoCl ₂ ·6H ₂ O	6.58	43.95	FeCl ₃ ·6H ₂ O
	29.36	7.77	"	5.99	44.50	"
	20.95	19.08	"	2.47	47.17	"
	10.13	35.52	"	4.74	51.57*	CoCl ₂ ·2H ₂ O + FeCl ₃ ·6H ₂ O
	7.99	41.07	"	0.0	49.42	FeCl ₃ ·6H ₂ O
	7.42	43.31	" + FeCl ₃ ·6H ₂ O			

*Metastable

Osaka and Yaginuma (1928) also give data for the quaternary system CoCl₂ + FeCl₃ + H₂O at 25°.

THE SYSTEM COBALT CHLORIDE - MERCURIC CHLORIDE - WATER AT 25°
(Bassett and Harry, 1930)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoCl ₂	HgCl ₂		CoCl ₂	HgCl ₂	
35.87	0.0	CoCl ₂ ·6H ₂ O	18.02	57.81	1.1.4 + HgCl ₂
30.69	15.14	"	15.14	56.54	HgCl ₂
26.04	30.68	"	13.95	54.92	"
23.38	41.25	"	8.59	37.39	"
21.54	51.00	" + 1.1.4	6.70	30.25	"
20.96	51.76	1.1.4	4.33	21.56	"
19.50	54.34	"	0.0	6.90	"
18.34	56.95	"			

1.1.4 = CoCl₂·HgCl₂·4H₂O.

Results for this system at 25° are also given by Benrath, 1927, but this investigator failed to find the double salt.

THE SYSTEM COBALT CHLORIDE - POTASSIUM CHLORIDE - WATER
(Benrath and Ritter, 1939 (0°, 38°, 50°, 75°, 99.5°); Mazzetti, 1926 (20°); Foote, 1927 (25°); see also Benrath, 1927 (25°))

Solid solutions are formed above 50°. Benrath and Ritter also give results at 51°.

Gms. per 100 gms. Saturated Solution			Gms. per 100 gms. Saturated Solution		
CoCl ₂	KCl	Solid Phase	CoCl ₂	KCl	Solid Phase
Results at 0°			Results at 25°		
3.95	18.58	K	0.0	26.46	K
12.60	12.33	K	7.50	20.29	K
16.05	10.22	K	16.09	14.19	K
28.4	5.44	K + Co ₆	24.71	10.19	K
			33.25	8.09	K
			34.10	8.24	K + Co ₆
			34.53	6.22	Co ₆
			34.77	4.43	Co ₆
			35.20	2.43	Co ₆
			35.67	0.0	Co ₆
Results at 20°			Results at 38°		
7.40	19.37	K	7.67	22.9	K
14.05	15.05	K	15.3	17.52	K
20.25	11.56	K	25.5	12.46	K
26.45	8.45	K	23.8	9.55	K
27.90	8.69	K	40.0	8.60	K + Co ₆
28.37	7.70	K	40.2	6.92	Co ₆
29.17	7.19	K	39.2	4.00	Co ₆
31.58	6.79	K			
33.15	6.81	K + Co ₆			
33.52	4.73	Co ₆			

K = KCl

Co6 = CoCl₂·6H₂O

(Cont.)

Co COBALT

Gms. per 100 gms. Saturated Solution		Gms. per 100 gms. Wet Residue		Solid Phase
CoCl ₂	KCl	CoCl ₂	KCl	
Results at 50°				
3.71	26.9	-	-	K
11.95	20.8	2.14	86.7	K
29.9	12.52	5.85	82.8	K
34.1	11.92	5.53	86.4	K
38.6	11.12	7.03	53.3	K
41.1	12.25	11.19	49.0	K + SS
40.5	12.82	39.6	44.0	K + SS
45.9	6.39	39.5	17.50	SS
47.0	5.16	49.1	4.26	SS + Co ₄
47.9	3.34	50.3	Trace	Co ₄
46.9	2.45	62.5	"	Co ₄
Results at 75°				
2.87	30.8	-	-	K
7.81	27.5	-	-	K
22.9	20.2	4.80	84.0	K
29.6	17.65	8.12	78.4	K
35.7	20.6	7.98	83.3	K
37.2	19.5	7.80	84.1	K
38.0	23.1	6.78	88.6	K
40.9	22.9	41.0	38.6	K + SS
40.4	28.1	39.2	47.4	K + SS
41.4	23.1	48.8	34.8	SS
43.3	19.30	51.6	24.8	SS
43.5	16.00	52.5	27.4	SS
44.6	15.27	54.5	22.7	SS
45.8	11.85	56.3	19.62	SS
48.0	8.18	56.0	13.20	SS
49.0	5.92	59.9	7.40	SS + Co ₂
50.1	1.19	72.9	Trace	Co ₂
Results at 99.5°				
7.58	30.8	2.39	81.6	K
15.80	28.8	2.78	92.0	K
21.4	27.6	5.86	82.5	K
29.2	25.1	5.77	87.2	K
28.5	27.8	4.83	89.3	K
32.9	27.9	7.00	86.0	K
36.7	28.6	21.9	59.9	K
40.5	36.1	25.7	63.7	K + SS
41.4	31.5	43.2	50.4	K* + SS
43.0	32.4	49.2	35.9	SS
44.6	26.4	51.1	26.1	SS
47.0	17.95	58.9	16.08	SS
49.0	11.74	64.9	10.45	SS
50.6	7.00	65.1	3.96	SS + Co ₂
49.1	4.90	74.1	Trace	Co ₂
51.1	3.24	66.3	1.48	Co ₂
51.4	2.85	69.9	0.69	Co ₂
K = KCl		Co ₂ = CoCl ₂ ·2H ₂ O		
Co ₆ = CoCl ₂ ·6H ₂ O		SS = Solid Solution		
Co ₄ = CoCl ₂ ·4H ₂ O		* = Blue KCl		

K = KCl

Co₆ = CoCl₂·6H₂OCo₄ = CoCl₂·4H₂OCo₂ = CoCl₂·2H₂O

SS = Solid Solution

* = Blue KCl

EQUILIBRIUM IN THE RECIPROCAL SALT PAIR
 $\text{CoCl}_2 + \text{K}_2\text{SO}_4 \rightleftharpoons \text{CoSO}_4 + (\text{KCl})_2$ AT 38°
 (Benrath and Ritter, 1939)

Gms. per 100 gms. sat. sol.				Solid Phase	
Cl ₂	SO ₄	K ₂	Co		
13.30	0.72	15.08	0.0	KCl + K ₂ SO ₄	
13.60	1.04	13.20	1.95	" "	
13.75	1.49	12.35	2.97	" "	
13.83	1.80	12.13	3.43	" "	
12.52	2.29	11.10	3.40	" "	
13.85	2.01	11.85	3.80	" " + 1.1.6	Cl
13.78	1.90	11.35	4.04	" + 1.1.6	
13.05	1.95	24.8	4.20	" "	
14.25	2.02	11.10	4.68	" "	
15.15	3.09	8.93	7.12	" "	
14.0	2.20	8.28	6.70	" "	
15.30	2.26	9.10	7.16	" "	
0.01	10.25	6.00	1.78	K ₂ SO ₄ + 1.1.6	
2.27	7.35	6.22	1.72	" "	
5.03	5.16	7.32	1.82	" "	
10.90	2.59	10.50	2.73	" "	
12.93	1.87	11.03	3.56	" "	
26.7	0.0	4.50	18.15	KCl + CoCl ₂ ·6H ₂ O	
26.5	0.52	5.34	18.24	" "	
26.3	1.14	3.45	18.4	" "	
24.4	2.48	4.93	18.0	" " + CoSO ₄ ·6H ₂ O	
0.0	21.3	1.85	11.7	CoSO ₄ ·7H ₂ O + 1.1.6	
7.9	11.68	2.06	12.08	" " + CoSO ₄ ·6H ₂ O	
19.30	2.91	0.0	18.30	CoSO ₄ ·6H ₂ O + CoCl ₂ ·6H ₂ O	

1.1.6 = Schönite $\text{CoSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$.

A number of additional points are given in terms of mols. of dry salts and number of molecules of water per 1 mol. of anhydrous salt mixture.

The authors give similar results for the isotherms at 0°, 50°, 75° and 99.5°.

THE SYSTEM COBALT CHLORIDE - LITHIUM CHLORIDE - WATER
 (Bassett and Sanderson, 1932)

This system was also studied at 25° by Benrath, 1927, but erroneous conclusions were drawn as a result, according to Bassett, of an insufficient number of determinations.

In a subsequent paper, Hanna Benrath, 1938-9, gives results for 16 different temperatures and constructs the polythermic diagram for the system. A method of preparing the saturated solutions designed to avoid metastability was employed and it was found that, after sufficient rotation the anomalous solid solutions reported by Bassett and Sanderson, 1932, gave place to cobalt chloride tetra hydrate which they failed to obtain. In other respects however, equilibrium is easily attained and remaining results agree satisfactorily with those of Bassett and Sanderson.

Co COBALT

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CoCl ₂	LiCl	Solid Phase	CoCl ₂	LiCl	Solid Phase
Results at 0°			Results at 40°—Contd.		
29.50	0.0	Co6	22.40	25.10	Co2
6.92	21.30	"	23.35	28.19	"
4.75	25.67	"	25.71	30.06*	"
7.71	31.90	"	24.99	30.06	" + 2.3.6
11.06	31.73*	"	24.30	30.68	2.3.6
13.81	31.32*	Co2	19.51	34.29	"
ci 13.87	29.48*	" + 2.7.18	18.97	34.29	"
10.47	31.56	Co6 + 2.7.18	16.36	36.75	"
8.45	33.21	2.7.18	18.19	39.74	" + SS
4.41	36.24	"	16.04	38.66*	SS
2.82	37.68	"	7.97	42.71	"
0.88	40.48	" + Li.2	4.17	44.88	"
0.00	40.87	Li.2	0.0	47.47	Li.1
Results at 25°			Results at 45°		
35.87	0.0	Co6	32.93	12.78	Co2
26.81	7.82	"	29.76	15.84	"
17.11	18.61	"	26.13	20.33	"
19.36	23.36	"	25.52	28.56	"
20.56	23.48	" + Co2	Results at 60°		
19.69	25.07	Co2	30.23	28.80	Co2
18.72	28.94	"	30.62	28.67	" + 1.1.2
20.32	31.06	"	28.62	30.57	1.1.2 + 2.3.6
20.16	31.12	2.3.6	27.84	31.64	1.1.2
19.20	32.19	"	Results at 80°		
17.25	33.24*	"	49.5	0.0	Co2
18.30	32.56	" + 2.7.18	33.23	17.19	"
17.60	32.96	2.7.18	31.67	26.67	"
15.53	33.85	"	32.84	28.44	" + 1.1.2
13.08	35.44	"	30.73	31.01	1.1.2
10.75	36.98	"	29.26	32.81	"
9.00	38.31	"	27.56	35.02	"
5.58	41.95	"	27.49	35.20	"
4.55	43.11	" + SS	26.29	37.25	" + SS
2.40	44.39	SS	25.85	37.48	SS
0.0	45.85	Li.1	24.99	37.93	"
Results at 40°			24.38	38.23	"
40.96	0.0	Co6	17.16	42.09	"
37.31	3.33	"	14.26	43.90	"
31.60	8.60	"	0.0	52.71	Li.1
31.35	13.94	"			
30.85	14.04	" + Co2			

Co6 = CoCl₂·6H₂O; Co2 = CoCl₂·2H₂O; 2.3.6 = 2CoCl₂·3LiCl·6H₂O;
 2.7.18 = 2CoCl₂·7LiCl·18H₂O; 1.1.2 = CoCl₂·LiCl·2H₂O; Li.2 = LiCl·2H₂O;
 Li.1 = LiCl·H₂O; SS = Solid Solution; * = metastable

(Cont.)

The authors give the following values for solutions simultaneously saturated with two and with three salts.

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	LiCl			CoCl ₂	LiCl	
0	0.89	40.5	Li ₂ + D·10	11	16.96	32.4	D·10 + Co ₄ + Co ₆
0	9.08	32.2	Co ₆ + "	13	17.24	32.3	" + " + Co ₂
48	45.5	0.0	" + Co ₄	24	18.95	32.3	" + D ₄ + "
56.5	41.1	0.0	Co ₂ + "	57.5	29.5	28.0	D ₂ + " + "
100	34.8	27.8	" + D ₂	20	1.86	44.1	Li·1 + Li ₂ + D·10
100	28.4	35.1	Li + "	32.5	9.15	41.8	" + D ₄ + "
92.5	0.0	54.6	" + Li·1	65	21.8	37.5	" + " + D ₂
20	0.0	45.3	Li ₂ + "	87.5	26.8	37.4	" + Li + "

Co₆ = CoCl₂·6H₂O; Co₄ = CoCl₂·4H₂O; Co₂ = CoCl₂·2H₂O;
 Li₂ = LiCl·2H₂O; Li·1 = LiCl·H₂O; Li = LiCl; D·10 = CoCl₂·4LiCl·10H₂O;
 D₄ = CoCl₂·2LiCl·4H₂O; D₂ = CoCl₂·LiCl·2H₂O.

THE SYSTEM COBALT CHLORIDE - MAGNESIUM CHLORIDE - WATER AT 25° (Bassett and Harry, 1930)

The analyses of the saturated solutions were made with considerable difficulty. The previous determinations of Benrath, 1927, at 25° were insufficient in number and accuracy to enable him to recognize the double compound CoCl₂·MgCl₂·8H₂O.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoCl ₂	MgCl ₂		CoCl ₂	MgCl ₂		CoCl ₂	MgCl ₂	
35.87	0.0	Co ₆	12.43	28.89	Co ₆ + 1.1.8	7.10	32.52	Mg ₆
28.78	6.20	"	11.61	29.72	1.1.8	6.65	32.80	"
19.16	15.40	"	10.54	30.54	"	4.97	33.55	"
12.56	22.70	"	10.00	31.00	"	3.93	34.30	"
11.09	28.78	"	8.95	31.66	" + Mg ₆	2.57	34.83	"
12.08	29.04	"	8.64	31.95	Mg ₆	0.0	36.20	"

Co₆ = CoCl₂·6H₂O; Mg₆ = MgCl₂·6H₂O; 1.1.8 = CoCl₂·MgCl₂·8H₂O.

THE SYSTEM COBALT CHLORIDE - AMMONIUM CHLORIDE - WATER

The data on this system leaves the exact nature of the solid phases at room temperature somewhat in doubt. The various investigators agree upon the compositions of the saturated solutions, but disagree on what solid phases are present. In general, it seems fairly well established that:

- (1) The system is "simple" at low temperatures, and the only solids present are NH₄Cl and CoCl₂·6H₂O.
- (2) Above 20° or 30° the compound 2NH₄Cl·CoCl₂·2H₂O exists and that it forms solid solutions with its components.

Co COBALT

At 25°, Foote, 1912 found that the solid phases were $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ and a solid solution of CoCl_2 in NH_4Cl (plus $2\text{H}_2\text{O}$). Very similar analytical data were obtained by Kurnakow, Luschnaja, and Kusnetzow (1937), but these authors reported that, in addition, the compound 2:1:2 was formed. They based their claim on relatively little data, and it seems inconclusive on this point. Benrath and Neuman, (1939) found neither the solid solution nor the double salt at 25°, and report the system to be simple. Additional data are given by Benrath (1927).

At 60° Clendinnen, 1922 found that the compound 2:1:2 was stable as a pure solid phase in contact with solutions containing 11-17% NH_4Cl . Solutions containing more or less NH_4Cl were in equilibrium with solid solutions.

Cl

Kurnakow, Luschnaja, and Kusnetzow, 1937 studied the system at 50° and found closely agreeing results. In addition, they found that pure $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$ existed in equilibrium with a range of solution compositions, and that it saturated an invariant solution with one of the solid solutions. This explained the rather sharp change in slope also found in Clendinnen's solubility curve, which had not been interpreted by him.

Benrath and Neumann, 1939 studied the system at 12 temperatures above 25°, including 50°, and although their analytical data agrees in part with those of Kurnakow, et al., their interpretation is quite different. They were apparently unaware of the results of Kurnakow, et al.

Benrath found the same four segments of the solubility curve which Kurnakow had described as the saturation curves of the phases:

- (1) Solid Solution
- (2) $2\text{NH}_4\text{Cl} \cdot \text{CoCl}_2 \cdot 2\text{H}_2\text{O}$
- (3) Solid Solution
- (4) $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$

- (1) Instead of a solid solution of CoCl_2 in NH_4Cl (found by all other workers) Benrath, using the method of wet residues, found only pure NH_4Cl to exist from 0° to 75°. At 100°, some solid solution was formed.
- (2)(3) The actual data for the rest of the system appear to confirm Kurnakow's conclusions as to the existence of the 2:1:2 compound and a second solid solution, but it has not been so interpreted by the authors. Benrath and Neumann report the formation of two compounds 2:1:2 and $\text{NH}_4\text{Cl} \cdot \text{CoCl}_2 \cdot 2\text{H}_2\text{O}$, and say that both of the compounds form solid solutions with each component, and do not exist as pure phases. Part of the disparity is due to lack of sufficient data along certain portions of the curves.
- (4) Both investigators found $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$ to exist.

Saturated Solution			Wet Residue		Solid Phase
Density	Wt. % NH_4Cl	Wt. % CoCl_2	Wt. % NH_4Cl	Wt. % CoCl_2	

Results at 0°
(Benrath and Neumann, 1939)

-	1.49	30.6	0.31	52.0	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$
-	4.37	29.4	0.34	53.2	"
-	7.42	28.0	2.02	52.0	"
-	7.35	27.8	23.5	39.3	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O} + \text{NH}_4\text{Cl}$
-	7.27	27.9	81.4	6.57	"
-	8.71	22.5	85.5	3.37	NH_4Cl
-	13.89	13.43	90.8	1.45	"
-	18.43	6.01	90.7	0.86	"
-	21.7	1.75	91.0	0.71	"
-	22.0	1.06	88.3	0.38	"

Cl

Results at 25°
(Kurnakow, Luschnaja, and Kusnetzow, 1937)

-	28.50	-	100.00	-	NH_4Cl
1.111	25.65	3.89	99.60	0.27	SS of $\text{NH}_4\text{Cl} + \text{CoCl}_2 + 2\text{H}_2\text{O}(\alpha)$
1.142	22.90	7.34	99.51	0.51	"
1.187	19.51	12.76	93.89	1.54	"
1.223	17.46	16.36	89.19	3.42	"
1.248	16.03	18.94	95.18	3.40	"
1.304	13.54	24.17	84.18	9.27	"
1.331	13.01	26.02	76.02	17.02	"
1.364	11.85	28.57	71.36	22.50	"
1.381	11.20	30.18	68.44	23.66	"
1.380	11.32	30.71	68.86	24.03	"
1.389	10.91	31.50	66.58	26.41	"
1.405	10.64	32.33	50.67	29.88	SS $\alpha + 2:1:2$
1.416	9.52	32.96	33.59	36.35	"
1.403	9.42	32.38	33.61	42.91	2:1:2
1.415	9.46	32.30	40.44	46.43	"
1.425	7.64	34.49	18.40	48.71	2:1:2 + $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$
1.430	7.70	34.36	16.79	49.94	"
1.423	5.19	35.01	0.28	55.27	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$
-	-	36.0	-	55.00	"

Results at 25°
(Foote, 1912)

17.90	15.63	-	3.2	Solid Solution of $\text{NH}_4\text{Cl} + \text{CoCl}_2 \cdot 2\text{H}_2\text{O}$
13.59	25.19	83.01	13.52	
8.75	34.28	35.12	50.66	
7.45	35.24	34.02	49.64	Solid Solution + $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$
7.62	34.61	7.07	55.27	

2:1:2 = $2\text{NH}_4\text{Cl} \cdot \text{CoCl}_2 \cdot 2\text{H}_2\text{O}$

SS = Solid Solution

(Cont.)

Co COBALT

Saturated Solution			Wet Residue		Solid Phase
Density	Wt. % NH ₄ Cl	Wt. % CoCl ₂	Wt. % NH ₄ Cl	Wt. % CoCl ₂	
Results at 50° (Kurnakow, Luschnaja and Kusnetzov, 1937)					
-	30.50	-	100.00	-	NH ₄ Cl
1.128	30.14	5.34	99.61	0.35	Solid Solution α
1.272	21.26	20.63	85.28	9.06	"
-	18.66	26.46	71.93	22.62	"
1.376	16.56	30.10	58.98	30.49	"
Cl 1.393	15.66	31.51	56.05	35.62	"
1.401	13.41	32.24	35.51	45.90	2:1:2
1.426	11.71	34.23	37.53	47.34	"
1.423	12.57	34.44	38.40	48.50	"
1.485	9.16	39.31	35.11	48.12	"
1.471	10.16	37.76	36.78	39.41	"
1.503	8.31	40.81	28.88	52.14	Solid Solution β
1.525	7.28	42.17	29.69	55.76	"
1.530	7.11	42.16	27.24	57.07	"
1.562	4.76	44.74	22.67	59.99	"
1.571	4.53	45.79	22.74	61.06	"
1.597	2.92	47.88	12.49	64.99	SS β + CoCl ₂ ·2H ₂ O
1.606	2.88	48.14	8.94	68.93	"
-	3.28	46.70	2.21	60.10	CoCl ₂ ·2H ₂ O
-	-	48.00	-	78.00	"

Results at 60°
(Clendinnen, 1922)

1.164	29.10	10.11	96.2	} % NH ₄ Cl in the solid solution by extrapolation	Solid Solution
1.240	25.25	17.53	88.8		"
1.329	21.32	25.86	67.6		"
1.362	18.15	30.66	55.8		"
1.380	17.74	31.24	52.7(unstable)		2:1:2
-	14.96	34.84	45.2		"
1.454	13.08	37.05	37.9		"
-	16.87	30.94	40.0		"
1.401	14.21	33.66	40.0		Solid Solution
1.414	13.57	34.36	38.8		"
-	12.93	35.02	38.8		"
-	12.56	35.64	38.8		"
-	11.80	37.01	38.4		"
1.482	10.36	40.14	31.0		"
1.504	9.04	41.42	29.4		"
1.530	6.90	43.56	25.0		"
1.559	5.02	45.74	21.2		"
1.580	3.44	47.44	12.7		"
1.575	2.59	48.06	8.0		"
1.592	2.21	48.21	6.7		"
1.587	1.79	48.37	2.6		"
1.585	0.90	48.62	1.1		"

2:1:2 = 2NH₄Cl·CoCl₂·2H₂O

SS = Solid Solution

THE SYSTEM COBALT CHLORIDE - SODIUM CHLORIDE - WATER

(Benrath and Neumann, 1938-9; Benrath, 1929; Foote, 1927; Mazzetti, 1926)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CoCl ₂	NaCl	Solid Phase	CoCl ₂	NaCl	Solid Phase
Results at 20° (M)			Result at 51° (B and N)		
34.98	0.00	CoCl ₂ ·6H ₂ O	45.2	2.61	CoCl·4H ₂ O + NaCl
33.38	3.35	"			
33.05	3.65	" + NaCl	Results at 60° (B and N)		
32.84	3.91	NaCl			Cl
28.26	6.07	"	49.1	0.27	CoCl ₂ ·2H ₂ O
27.73	6.63	"	48.3	2.02	"
21.45	10.32	"	47.5	2.42	"
13.63	15.71	"	Results at 98° (B)		
8.20	19.40	"			
0.00	26.09	"			
Results at 25° (F)(B and N)			Dissolved Gm. mols.		
			CoCl ₂	NaCl	Gm. mols. H ₂ O to dissolve 1 gm. sol. CoCl ₂ + NaCl
35.67	0.0(F)	CoCl ₂ ·6H ₂ O			
35.3	1.8	"			
34.59	2.01(F)	"	1.00	0.00	6.67
33.22	4.23(F)	"	0.9063	0.0937	6.15
33.0	4.5	" + NaCl	0.8046	0.1954	5.44
32.92	4.69(F)	" + "	0.7460	0.2540	5.14
31.62	4.58(F)	NaCl	0.7210	0.2790	5.49
25.82	7.82(F)	"	0.547	0.453	7.56
23.8	9.15	"	0.310	0.690	8.32
18.6	12.20	"	0.170	0.830	8.48
16.00	14.11(F)	"	0.107	0.893	8.56
13.0	17.3	"	0.030	0.970	8.58
7.8	21.2	"	0.000	1.000	8.33
7.17	20.73(F)	"	Results at 100° (B and N)		
4.93	23.3	"			
0.0	26.50(F)	"			
Results at 38° (B and N)			Gms. per 100 gms. sat. sol.		
			CoCl ₂	NaCl	Solid Phase
38.8	2.63	CoCl ₂ ·6H ₂ O			
38.3	3.34	" + NaCl	50.3	2.30	CoCl ₂ ·2H ₂ O
27.8	7.61	NaCl	50.1	3.63	"
17.35	12.7	"	49.4	4.99	"
9.15	18.1	"	48.6	5.30	"
			50.0	5.76	" + NaCl
Results at 50° (B and N)			44.4	6.44	NaCl
			37.2	9.04	"
13.0	17.3	NaCl	24.9	14.16	"
7.8	21.2	"	9.90	21.7	"
4.93	23.3	"			

Co COBALT

THE SYSTEM COBALT CHLORIDE - NICKEL CHLORIDE - WATER AT 25°
(Osaka and Yaginuma, 1928)

These chlorides form a complete series of solid solutions with six molecules of water of crystallization.

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	NiCl ₂		CoCl ₂	NiCl ₂	
	36.08	0.0	CoCl ₂ ·6H ₂ O	11.83	26.13	(Co·Ni)Cl ₂ ·6H ₂ O
	32.06	4.31	(Co·Ni)Cl ₂ ·6H ₂ O	7.66	30.63	"
Cl	26.17	10.45	"	6.28	31.91	"
	23.42	13.39	"	4.38	34.36	"
	14.87	22.51	"	0.0	38.88	NiCl ₂ ·6H ₂ O

THE SYSTEM COBALT CHLORIDE - RUBIDIUM CHLORIDE - WATER AT 25°
(Foote, 1927)

This system was also studied by Benrath, 1927, at 25° but the double salt, CoCl₂RbCl·2H₂O, which exists over a very narrow range of concentration, could not be identified.

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CoCl ₂	RbCl		CoCl ₂	RbCl	
	35.67	0.0	Co6	31.74	9.34	1.2.2
	35.20	3.38	"	28.89	12.31	"
	35.11	5.98	" + 1.1.2	16.09	30.52	"
	34.92	6.20	" "	11.37	38.83	" + RbCl
	34.58	6.83	1.1.2	11.62	38.03	" "
	34.29	7.79	" + 1.2.2	5.41	43.58	RbCl
	34.43	7.56	" "	0.0	48.57	"

Co6 = CoCl₂·6H₂O; 1.1.2 = CoCl₂·RbCl·2H₂O; 1.2.2 = CoCl₂·2RbCl·2H₂O.

THE SYSTEM COBALT CHLORIDE - STRONTIUM CHLORIDE - WATER
(Bassett, Gordon and Henshall, 1937)

The results of Benrath (1927) at 25° are in agreement with these.

Results at 25°			Results at 50°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoCl ₂	SrCl ₂		CoCl ₂	SrCl ₂	
35.87	0.0	CoCl ₂ ·6H ₂ O	49.50	0.0	CoCl ₂ ·2H ₂ O
32.57	4.28	"	42.16	10.71	"
29.21	9.00	"	41.02	12.25	"
26.90	12.19	" + SrCl ₂ ·6H ₂ O	31.98	22.16	" + SrCl ₂ ·2H ₂ O
26.57	12.31	" "	33.77	22.30	" "
24.55	13.69	SrCl ₂ ·6H ₂ O	24.45	29.24	SrCl ₂ ·2H ₂ O
24.17	14.50	"	18.05	34.12	"
10.83	24.93	"	0.0	47.50	"
0.0	35.07	"			

THE SYSTEM COBALT CHLORIDE - THORIUM CHLORIDE - WATER
(Bassett, Gordon and Henshall, 1937)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
CoCl ₂ ThCl ₄		CoCl ₂ ThCl ₄					
Results at 0°				Results at 25°—Contd.			
0.55	55.20	CoCl ₂ ·6H ₂ O + ThCl ₄ ·8H ₂ O	7.85	42.46	CoCl ₂ ·6H ₂ O		
0.0	55.67	ThCl ₄ ·8H ₂ O	4.21	54.25	" + ThCl ₄ ·8H ₂ O		
Results at 25°			3.34	55.17	ThCl ₄ ·8H ₂ O		
22.47	18.50	CoCl ₂ ·6H ₂ O	1.97	56.25	"		
17.34	26.26	"	0.0	58.00	"		

Cl

THE SYSTEM COBALT CHLORIDE - ZINC CHLORIDE - WATER AT 25°
(Bassett and Harry, 1930)

This is a very complex system due to the ease of hydrolysis of zinc chloride and the formation of solid solutions of the two salts. A special procedure for the preparation of the mixtures was necessary and the saturated solutions were analyzed only with considerable difficulty. The several determinations of Benrath, 1927, upon this system at 25° fall fairly near the curve drawn from the present results.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoCl ₂	ZnCl ₂		CoCl ₂	ZnCl ₂		CoCl ₂	ZnCl ₂	
35.87	0.0	Co6	13.77	59.92	SSB	12.32	64.03	SSD
32.03	9.26	"	12.91	61.15	"	10.18	66.98	"
29.35	21.75	"	12.28	63.08	"	9.59	67.72	"
30.86	26.74	"	12.40	63.38	"	9.48	67.46	"
31.20	27.91	" + Co2	12.61	63.40	" + SSC			
31.08	28.43	Co2	15.78	59.54	SSC	5.37	73.82	"
29.77	32.16	"	12.63	63.40	"	4.19	77.38	"
29.40	33.62	"	12.16	64.00	"	4.70	77.67	SSE
29.48	33.31	" + SSA	7.35	69.88	"	0.61	80.02	SSC + SSE
28.22	33.31	SSA	5.69	72.07	"	0.0	80.88	Zn1 ₁
26.09	37.86	"	3.97	74.50	"	2.60	78.58	Zn(1)
22.20	43.09	"	2.76	76.09	"	0.0	81.5	"
19.56	47.00	"	2.34	76.98	"	2.45	79.02	Zn(2)
17.45	50.00	"	0.43	80.19	"	-	81.5	"
12.34	59.29	"	0.0	81.78	Zn1 ₂	2.06	79.20	"(3)
13.19	60.10	"	17.23	57.95	SSC + SSD	-	81.41	"
13.51	60.09	" + SSB	15.36	60.09	SSA + SSD			

Co6 = CoCl₂·6H₂O; Co2 = CoCl₂·2H₂O; Zn1₁ = ZnCl₂·1 $\frac{1}{3}$ H₂O; Zn1₂ = ZnCl₂·1 $\frac{2}{3}$ H₂O.
SSA = Solid Solution A = [Zn(H₂O)₆]⁺⁺[ZnCl₄]⁻ (= ZnCl₂·3H₂O) and [Co(H₂O)₆]⁺⁺[ZnCl₄]⁻.
SSB = Solid Solution B = [Zn₂(H₂O)₁₀]⁺⁺·[ZnCl₄]⁻ (= ZnCl₂·2.5H₂O) and [Co₂(H₂O)₁₀]⁺⁺·[ZnCl₄]₂⁻.

(Continued)

SSC = Solid Solution C = $[Zn_2(H_2O)_{10}]^{++++}[Zn_2Cl_6]_2^{-} (= ZnCl_2 \cdot 1\frac{1}{3}H_2O)$ and $[Co_2(H_2O)_{10}]^{++++}[Zn_2Cl_6]_2^{-}$.
 SSD = Solid Solution D = $[Zn_2(H_2O)_6]^{++++}[ZnCl_4]_2^{-} (= ZnCl_2 \cdot 1\frac{1}{3}H_2O)$ and $[Co_2(H_2O)_6]^{++++}[ZnCl_4]_2^{-}$.
 SSE = Solid Solution E = $[Zn(H_2O)_4]^{++}[Zn_2Cl_6]^{-} (= ZnCl_2 \cdot 1\frac{1}{3}H_2O)$ and $[Co(H_2O)_4]^{++}[Zn_2Cl_6]^{-}$.

- (1) $ZnCl_2$ (Hexagonal plates)
- (2) $ZnCl_2$ (octohedra)
- (3) $ZnCl_2$ (long double pyramids)

Cl

SOLUBILITY OF ANHYDROUS COBALT CHLORIDE IN PURE METHYL
AND IN PURE ETHYL ALCOHOL

(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928)

(Older results are given by Winkler, 1864 and Bodtker, 1897)

Results for Methyl Alcohol			Results for Ethyl Alcohol		
t°	Gms. $CoCl_2$ per 100 gms. CH_3OH	Solid Phase	t°	Gms. $CoCl_2$ per 100 gms. C_2H_5OH	Solid Phase
20	38.5	$CoCl_2 \cdot 3CH_3OH$	0	45.0	$CoCl_2 \cdot 3C_2H_5OH$
25	43.6	"	10	48.6	"
28	46.5	"	20	54.4	"
30	48.8	"	30	62.6	"
35	55.5	"	40	67.4	$CoCl_2 \cdot 2C_2H_5OH$
37	58.9	"	50	65.1	"
38	58.8	$CoCl_2 \cdot 2CH_3OH$	60	66.8	"
40	58.2	"	70	72.9	"
50	58.9	"	80	70.3	"

THE SYSTEM COBALT CHLORIDE - t-BUTANOL - WATER AT 25°
(Katzin and Ferraro, 1953)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H_2O	$CoCl_2$	Solid Phase	H_2O	$CoCl_2$	Solid Phase
0.37	4.55	$CoCl_2$	1.27	8.66	$CoCl_2 \cdot 2H_2O$
0.23	5.38	"	1.69	8.55	"
0.65	7.87	"	1.47	4.71	"
0.77	8.03	"	1.63	2.80 Av.	" + D
0.98	10.49	"	1.91	2.38	D
1.05	11.29	"	2.28	1.80	"
2.24	15.35	" + $CoCl_2 \cdot H_2O$	3.72	0.82 Av.	" + $CoCl_2 \cdot 6H_2O$
1.89	14.98	$CoCl_2 \cdot H_2O$	6.15	0.97	$CoCl_2 \cdot 6H_2O$
2.10	12.06	"	7.33	1.31	"
2.24	10.10	"	11.54	3.32	"
1.95	8.80 Av.	" + $CoCl_2 \cdot 2H_2O$			

D = $CoCl_2 \cdot 4H_2O \cdot 2t \cdot (CH_3)_3COH$

(Cont.)

THE SYSTEM COBALT CHLORIDE - t-BUTANOL - WATER AT 25°--Contd.

Two Liquid Region

Organic Rich Wt. %		Water Rich Wt. %		Organic Rich Wt. %		Water Rich Wt. %	
H ₂ O	CoCl ₂	H ₂ O	CoCl ₂	H ₂ O	CoCl ₂	H ₂ O	CoCl ₂
51.54	42.33	(Plait point)		-	-	70.80	15.40
49.94	5.50	-	-	22.75	2.46	69.41	18.97
-	-	58.41	7.18	20.68	2.93	67.98	20.63
41.25	4.30	64.53	8.82	18.80	2.73	67.74	21.84
37.77	3.99	65.08	8.61	13.24	3.64	61.95	31.40
-	-	68.86	10.38	12.57	4.05	59.54	34.41
-	-	69.46	10.94	12.45	4.01	60.92	33.53
-	-	70.76	12.00	12.40	3.95	62.06	32.50
-	-	71.19	13.91	11.99	3.97	59.15	36.51*

Cl

*Solid CoCl₂·6H₂O also present.

THE SYSTEM COBALT CHLORIDE - ACETONE - WATER AT 25°

(Katzin and Ferraro, 1952)

The system is characterized by two distinct retrograde solubility curves of the hexa and dihydrates.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H ₂ O	CoCl ₂	Solid Phase	H ₂ O	CoCl ₂	Solid Phase	H ₂ O	CoCl ₂	Solid Phase
64.52	35.72	6	10.76	18.18	4 + 3	2.82	16.91	0
47.21	28.29	6	10.25	17.60	3 + 2	2.68	16.69	0
43.23	26.83	6	9.18	16.95	2	3.10	15.92	0
31.87	21.15	6	5.98	8.11	2	2.15	13.49	0
17.27	11.33	6	1.71	5.67	2	2.03	12.15	0
11.61	5.79	6	1.71	6.25	2	1.72	10.15	0
8.80	3.69	6	2.91	8.60	2	1.76	8.54	0
7.25	3.60	6	4.74	16.57	2	1.28	6.60	0
7.44	7.58	6	4.56	19.53	2	1.06	5.70	0
7.47	8.42	6	4.66	20.11	2	0.73	4.55	0
7.34	9.18	6	3.79	22.86	2 + 1	0.95	4.08	0
10.89	16.73	6	3.36	20.94	1	0.87	3.03	0
11.23	17.95	6 + 4	3.36	18.62	1 + 0	0.43	2.52	0
						0.07	2.25	0
6 = CoCl ₂ ·6H ₂ O			4 = CoCl ₂ ·4H ₂ O			2 = CoCl ₂ ·2H ₂ O		
1 = Probably CoCl ₂ ·H ₂ O			0 = probably CoCl ₂			3 = CoCl ₂ ·3H ₂ O		

Co COBALT

SOLUBILITY OF ANHYDROUS COBALT CHLORIDE IN ABSOLUTE ACETONE AT VARIOUS TEMPERATURES (Hall, Rowlands, Bamford, Thomas, and Jones, 1930)

The earlier determinations of von Laszczynski, 1894 and Krug and McElroy 1892 are too high. Naumann's (1904) value at 18° is 2.75.

t°	Gms. CoCl ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase	t°	Gms. CoCl ₂ per 100 gms. CH ₃ COCH ₃	Solid Phase
0	4.47	CoCl ₂ ·C ₃ H ₆ O	25	3.71	CoCl ₂
10	3.32	"	30	4.51	"
20	2.89	CoCl ₂	40	6.01	"
Cl 22.5	3.40	"	50	7.25	"

THE SYSTEM COBALT CHLORIDE - PYRIDINE (Pearce and Moore, 1913)

t°	Gms. CoCl ₂ per 100 gms. Sat. Sol.	Solid Phase	t°	Gms. CoCl ₂ per 100 gms. Sat. Sol.	Solid Phase
-48.2	0	C ₅ H ₅ N	55	1.192	1.4
-50.3 Eutec.	...	" + 1.6	60	1.324	"
-45	0.4185	1.6	64.2	1.460	"
-30	0.4205	"	68	1.572	"
-19.6	0.4208	"	70 tr. pt.	...	" + 1.2
-10	0.4310	"	74.8	2.037	1.2
0	0.4307	"	78.2	2.276	"
15 tr. pt.	...	1.6 + 1.4	79.8	2.428	"
23	0.569	1.4	88	3.284	"
25	0.575	"	90 tr. pt.	...	" + CoCl ₂
34.6	0.749	"	96.5	7.251	CoCl ₂
37.6	0.754	"	98.8	7.936	"
44.6	0.950	"	106	12.540	"
47.2	1.020	"	110	14.165	"
51	1.110	"			

1.6 = CoCl₂·6C₅H₅N.

1.4 = CoCl₂·4C₅H₅N.

1.2 = CoCl₃·2C₅H₅N.

SOLUBILITY OF COBALT (ous) CHLORIDE IN VARIOUS ORGANIC SOLVENTS
[Garwin and Hixson (1949), except as noted]

The anhydrous salt was used throughout.

Gms. CoCl ₂ per 100 gms.			Gms. CoCl ₂ per 100 gms.		
Solvent	t°	Sat. Sol.	Solvent	t°	Sat. Sol.
n-Butyl Alcohol	25	34.6	Methyl Ethyl Ketone	25	2.13
n-Amyl Alcohol	25	32.2	Methyl n-Propyl Ketone	25	1.20
2-Methyl-4-Butanol	25	29.2	Methyl Iso Butyl Ketone	25	0.41
n-Hexyl	25	29.0	Diethyl Ketone	25	.53
2-Ethyl-1-Butanol	25	27.3	Diiso Propyl Ketone	25	.52
2-Ethyl-1-Hexanol	25	26.2	Acetophenone	25	.33
Capryl-2-Octanol:			Ethyl Ether	25	.021*
"Commercial"	25	21.3	Iso Propyl Ether	25	.01
"Ketone Free"	25	22.4	n-Heptane	25	.04
Ethyl Acetate	14	0.08 ¹	Benzene	25	.02
	25	1.08	Nitro Methane	25	.01
	79	0.26 ¹	Nitrobenzene	25	.02
Iso Propyl Acetate	25	0.93	Ethylene Dichloride	25	.00
Iso Valeric Acid	25	2.3	Chlorobenzene	25	.02
Benzaldehyde	25	0.29	Ethylene Glycol	Room	10.7 ²
Furfural	25	0.06	Acetonitrile	18	3.93 ³
45% Formic Acid	20.5	5.8 ³	Methyl acetate	18	0.368 ⁴

¹von Laszczynski, 1894

²de Coninck, 1905

³Naumann and Schlier, 1914

⁴Naumann (1909) d₁₈ sat. sol. = 0.938

⁵Aschan, 1913

*Same value found by Bodtker, 1897

DISTRIBUTION OF COBALT CHLORIDE BETWEEN CAPRYL ALCOHOL AND WATER AT 25°
(Garwin and Hixson, 1949)

Aqueous phase wt. % CoCl ₂	35.6	33.2	30.7	27.6
Alcohol phase wt. % CoCl ₂	0.0669	0.0400	0.0297	0.0097

Results are also given for mixtures of CoCl₂ + NiCl₂.

RESULTS IN THE PRESENCE OF HYDROCHLORIC ACID
(Garwin and Hixson, 1949a)

In each experiment the aqueous phase contained 9-13 wt. % CoCl₂.
Data are also given for the distributions in the presence of CaCl₂, NiCl₂
and mixtures of NiCl₂ + CaCl₂.

(Cont.)

Co COBALT

RESULTS IN THE PRESENCE OF HYDROCHLORIC ACID--Contd.

Wt. % Total Cl in Aqueous Phase	K Co Alc. Aq.	K HCl Alc. Aq.	Wt. % Total Cl in Aqueous Phase	K Co Alc. Aq.	K HCl Alc. Aq.
9.7	0.29×10^{-3}	0.112	24.5	1.76×10^{-1}	.422
12.1	.66 "	.202	25.6	2.40 "	.425
14.0	1.50 "	.282	26.4	2.94 "	.425
15.3	2.23 "	.329	26.7	3.26 "	.435
16.4	5.06 "	.364	27.2	3.40 "	.430
17.5	8.35 "	.395	27.7	3.43 "	.447
19.1	1.68×10^{-2}	.398	28.1	3.82 "	.448
20.1	3.06 "	.400	29.1	4.15 "	.444
21.4	5.48 "	.416	31.3	4.93 "	.448
22.0	7.15 "	.410	31.6	4.92 "	.460
23.0	1.10×10^{-1}	.424			

One liter of a saturated solution of $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ in furfural contains 5 gms. $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ at 25° (Trimble, 1941).

At 0° , 100 cc of a mixture of equal volumes of H_2O + $(\text{C}_2\text{H}_5)_2\text{O}$ saturated with HCl will dissolve 7.7 gms. of CoCl_2 . (Fischer and Seidel, 1941)

SOLUBILITY OF COBALT CHLORIDE IN INORGANIC LIQUIDS

Solvent	t°	Gms. CoCl_2 per 100 gms. solvent	Author
Anhydrous Hydrazine	Approx. 15	Approx. 1	(Welsh and Broderson, 1915)
Liquid SO_2	0	0.013	(Jander and Ruppolt, 1937)
SeOCl_2	25	0.17	(Wise, 1923)

Melting point data are given for the following mixtures:

$\text{CoCl}_2 + \text{FeCl}_3$	(Ferrari, Celeri and Giorgi, 1929)
" + LiCl	(Ferrari and Baroni, 1928; Lesnykh and Bergman, 1953)
" + PbCl_2	(Ferrari and Colla, 1933)
" + SnCl_2	(" " " ")
" + SrCl_2	(Ferrari and Inganini, 1930)
" + ZnCl_2	(" " " " ; Bassett and Bedwell, 1931)
" + CoSO_4	(Lesnykh and Bergman, 1953)
$\text{CoCl}_2 + \text{Li}_2\text{SO}_4 \rightleftharpoons \text{CoSO}_4 + 2\text{LiCl}$ (Lesnykh and Bergman, 1953)	

COBALT Choline CHLORIDE $(\text{CH}_3)_2\text{NCIC}_2\text{H}_4\text{OH} \cdot \text{CoCl}_2$

0.1 gms. are dissolved in 100 ml. of solution in water at room temperature. (Seaman, Hugonet, and Leibmann, 1949)

COBALT Triethylene diamine CHLORIDE

Cl

Data on the solubility in water are given by Rostkovski, 1927.

COBALT dimethylglyoxime CHLORIDE

(Data of Babko and Korotun, 1954)

D = Dimethyl glyoxime

Formula	Gms. salt per 100 ml H ₂ O at 20°
H(CoHD) ₂ Cl ₂	2.
(CoHD) ₂ Cl·H ₂ O	0.17

COBALT CHLORATE Co(ClO₃)₂

ClO

SOLUBILITY IN WATER
(Meusser, 1902)

t°	Gms. Co(ClO ₃) ₂ per 100 Gms. Solution	Mols. Co(ClO ₃) ₂ per 100 Mols. H ₂ O	Solid Phase
-12	29.97	3.41	Ice
-21	53.30	9.08	Co(ClO ₃) ₂ ·6H ₂ O
-19	53.61	9.20	"
0	57.45	10.75	"
10.5	61.83	12.90	"
18	64.19	14.28	Co(ClO ₃) ₂ ·4H ₂ O
21	64.39	14.51	"
35	67.09	16.10	"
47	69.66	18.29	"
61	76.12	25.39	"

Density of solution saturated at 18° = 1.861.

COBALT PERCHLORATE Co(ClO₄)₂

ClO

SOLUBILITY IN WATER
(Goldblum and Terlikowski, 1912)

t°	Gms. Co(ClO ₄) ₂ per 100 Gms. H ₂ O	Solid Phase
-10.9	32.67	Ice
-30.7	58.16	"
-62.2 Eutec.	...	Ice + Co(ClO ₄) ₂ ·9H ₂ O
-30.7	83.2	Co(ClO ₄) ₂ ·9H ₂ O
-21.3	90.6	"

(Cont.)

Co COBALT

SOLUBILITY OF $\text{Co}(\text{ClO}_4)_2$ IN WATER--Contd.

t°	Density Sat. Sol.	Gms. $\text{Co}(\text{ClO}_4)_2$ per 100 Gms. H_2O	Solid Phase
0	1.564	100	$\text{Co}(\text{ClO}_4)_2 \cdot 5\text{H}_2\text{O}$
7.5	1.566	101.9	"
18	1.567	103.8	"
26	1.581	113.4	"
45	1.588	115	"

SOLUBILITY OF COBALT PERCHLORATE IN SEVERAL SOLVENTS (Chaney and Mann, 1931)

The determinations were made by adding at room temperature successive small amounts of solvent to a weighed amount of the salt until upon vigorous shaking the last trace of perchlorate just disappeared.

Solvent	Gms. $\text{Co}(\text{ClO}_4)_2$ per 100 cc solvent
Water	292 (Salvadori, 1912)
Furfural ($\text{C}_4\text{H}_3\text{OCHO}$) $d_{20}^{25} = 1.1550$	60
Cellosolve (monoethylether of ethylene glycol)	110

C10 COBALT Hexa Antipyrine Per CHLORATE $[\text{Co}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$

100 cc sat. solution in water contain 6.62 gm. $[\text{Co}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$ at 20°. (Wilke-Dörfurt and Schliephake, 1929)

COBALT Diaminocyclopentane per CHLORATE

Data for the solubility of this compound in water is given by Jaeger and Bluemendal, 1928.

F COBALT FLUORIDE CoF_2

SOLUBILITY IN WATER AND IN AQ. 3% HF SOLUTION (Kurtenacker, Finger and Hey, 1933)

Solid Phase $\text{CoF}_2 \cdot 4\text{H}_2\text{O}$ in all cases.
The result at 25° by Carter, 1928.

Results for H_2O		Results for Aq. 3% HF solutions			
t°	Gms. CoF_2 per 100 cc sat. sol.	t°	Gms. per 100 gms. sat. sol.	t°	Gms. per 100 gms. sat. sol.
20	1.36	20	3.35	80	3.90
25	1.415	40	3.48	90	4.61
		50	3.60	100	5.43

(Cont.)

At higher concentrations of HF the solubility increases rapidly; at 20° in 11.5% HF there is 5.9% CoF_2 and in 13.5% HF, 9.6% CoF_2 .

THE SYSTEM COBALT FLUORIDE - POTASSIUM FLUORIDE - WATER
(Kurtenacker, Finger and Hey, 1933)

Results at 20°

Results at 50°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoF_2	KF		CoF_2	KF	
0.86	1.2	Mixed Crystals	0.012	4.3	Mixed Crystals
0.18	1.6	"	0.005	11.0	"
0.11	2.3	"	-	15.5	"
0.013	13.8	"	-	23.2	"
0.005	20.8	"	-	27.3	"
-	32.6	"	-	35.8	"

THE SYSTEM COBALT FLUORIDE - AMMONIUM FLUORIDE - WATER
(Kurtenacker, Finger and Hey, 1933)

Results at 20°

Results at 50°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoF_2	NH_4F		CoF_2	NH_4F	
0.34	2.9	$\text{CoF}_2 \cdot 4\text{H}_2\text{O}$	0.40	3.6	$\text{CoF}_2 \cdot 4\text{H}_2\text{O}$
0.21	9.7	"	0.08	14.5	$\text{CoF}_2 \cdot 2\text{NH}_4\text{F} \cdot 2\text{H}_2\text{O}$
0.08	12.4	$\text{CoF}_2 \cdot 2\text{NH}_4\text{F} \cdot 2\text{H}_2\text{O}$	0.06	17.3	"
0.02	18.4	"	0.03	22.6	"
0.015	20.8	"	0.015	24.8	"
0.010	24.1	"	0.014	27.6	"
0.009	34.3	"	0.013	29.5	"

SOLUBILITY OF COBALT FLUORIDES IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

Cobaltous Fluoride

Cobaltic Fluoride

t°	Gms. CoF_2 per 100 gms. HF	t°	Gms. CoF_3 per 100 gms. HF
-23.2	0.040	-23.8	0.272
-4.4	0.033	-9.8	0.264
+14.2	0.036	+11.9	0.257

Co COBALT

F COBALT Hexa Antipyrine (FLUOBORATE) $[\text{Co}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_2$

100 cc sat. solution in water contains 13.1 gm. $[\text{Co}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_2$ at 20°. (Wilke-Dorfurt and Mureck; 1929)

I COBALT IODIDE CoI_2

SOLUBILITY IN WATER (Etard, 1891, 1894)

The accuracy of these results is doubtful.

Gms. CoI_2 per 100 Gms.			Gms. CoI_2 per 100 Gms.		
t°	Solution	Solid Phase	t°	Solution	Solid Phase
-10	55.5	$\text{CoI}_2 \cdot \text{H}_2\text{O}$ (green)	25	67.5	$\text{CoI}_2 \cdot \text{H}_2\text{O}$ (olive)
0	58.0	"	30	70.0	"
10	61.5	"	40	75.0	$\text{CoI}_2 \cdot \text{H}_2\text{O}$ (yellow)
15	63.2	"	50	79.0	"
20	65.2	"	80	80.0	"
25	67	"	110	81.0	"

SOLUBILITY IN LIQUID SO_2

100 gms. liquid sulfur dioxide dissolve 0.382 gm. CoI_2 at 0°. (Jander and Ruppolt, 1937)

IO COBALT IODATE $\text{Co}(\text{IO}_3)_2$

SOLUBILITY IN WATER (Meusser, 1901)

t°	Solid Phase: $\text{Co}(\text{IO}_3)_2 \cdot 4\text{H}_2\text{O}$		$\text{Co}(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$		$\text{Co}(\text{IO}_3)_2$	
	G	M	G	M	G	M
0	0.54	0.028	0.32	0.014	...	...
18	0.83	0.038	0.45	0.020	1.03	0.046
30	1.03	0.046	0.52	0.023	0.89	0.040
50	1.46	0.065	0.67	0.030	0.85	0.030
60	1.86	0.084	...	...	...	...
65	2.17	0.098	...	...	...	...
75	...	...	0.84	0.038	0.75	0.033
100	...	...	1.02	0.045	0.69	0.031

G = Gms. $\text{Co}(\text{IO}_3)_2$ per 100 gms. solution. M = Mols. $\text{Co}(\text{IO}_3)_2$ per 100 Mols. H_2O .

SOLUBILITY OF COBALT IODATE IN AQUEOUS SALT SOLUTIONS AT 30°
(Trimble, 1936)

Results for aqueous solutions of:

Sodium Chloride			Sodium Iodate			Cobalt Sulfate		
d. of sat. sol.	Gms. mols. per 1000 gms. sat. sol.		d. of sat. sol.	Gm. mols. per 1000 gms. sat. sol.		d. of sat. sol.	Gm. mols. per 1000 gms. sat. sol.	
	NaCl	Co(IO ₃) ₂		NaIO ₃	Co(IO ₃) ₂		CoSO ₄	Co(IO ₃) ₂
1.0006	0.0	0.01165	1.0006	0.0	0.01165	1.0006	0.0	0.01165
1.0007	0.0029	0.0119	1.0006	0.0044	0.0102	1.0008	0.0026	0.0113
1.0008	0.0052	0.0120	1.0007	0.0076	0.0093	1.0011	0.0052	0.0111
1.0009	0.0069	0.0121	1.0008	0.0087	0.0090	1.0012	0.0161	0.0111
1.0010	0.0111	0.0124	1.0011	0.0127	0.0080	1.0019	0.0123	0.0107
1.0011	0.0140	0.0125	1.0014	0.0174	0.0069	1.0020	0.0129	0.0106
1.0016	0.0267	0.0131	1.0017	0.0204	0.0063	1.0034	0.0235	0.0102
1.0020	0.0355	0.0134	1.0026	0.0280	0.0050	1.0037	0.0258	0.0101
1.0029	0.0532	0.0139	1.0037	0.0360	0.0040	1.0076	0.0516	0.0095
1.0054	0.0941	0.0149	1.0056	0.0483	0.0030	1.0117	0.0774	0.0094
1.0085	0.1449	0.0158	1.0135	0.0999	0.0010	1.0155	0.1032	0.0093

The solid phase was Co(IO₃)₂·2H₂O in all cases.

COBALT AMMINES

(NH₃)

SOLUBILITIES IN WATER

The solubility of the amines has been studied exhaustively by the following authors. In general, equilibrium was assured and the agreement among various sets of data is good. A large number of solubilities were determined in aqueous solutions of salts and acids, and also in methyl and ethyl alcohols. Most of these data are not reproduced in the following tables.

REFERENCES FOR TABLES FOLLOWING

- (1) Ephraim and Mosimann, 1922; (2) Brønsted and Peterson, 1921; (3) Litvinov, 1940; (4) Benrath 1926; Benrath and Wurzberger, 1924; (5) Hansen and Williams, 1930 [also give data in aq. NaCl and aq. C₂H₅OH]; (6) Baker and Barat, 1930; (7) LaMer, King and Mason, 1927; (8) LaMer and Cook, 1929; (9) LaMer and Mason, 1927; (10) Brønsted and Volquartz, 1928; (11) Brønsted and Brumbaugh, 1926; (12) Lal De, 1917; (13) Jørgensen, 1878, 1879; Kurnakoff, 1892; (14) Yatmirskii, Prik, Skvirskaya and Starostin, 1951; (15) Ephraim and Flugel, 1924; (16) Brønsted, Delbanco and Volquartz, 1932; (17) Ephraim, 1923; (18) Lamb and Simmons, 1921; (19) Brønsted, 1923; (20) Ephraim and Flugel, 1924; (21) Partington and Stonehill, 1936; O'Neill and Partington, 1934; (22) Brønsted, 1919, 1922; (23) Strock and McCutcheon, 1931; (24) Gross and Kahn, 1955 (also give data in aq. alcohols); (25) Mayper, Clever and Verhoeck, 1954 (also give data in aq. dioxane); (26) Pederson, 1941 (also data in urea and dioxane solutions); (27) Linhard and Flygarr, 1943; (28) Linhard and Rau, 1953; (29) Wilke-Dörfert and Gunzert, 1933; (30) Yatmirskii, 1950; (31) Linhard and Berthold, 1955.

Co COBALT

COBALT HEXAMMINES ("LUTEO" compounds) $[\text{Co}(\text{NH}_3)_6]^{+++}$

	Formula	t°	moles salt per liter sat. sol.	Author (p. 823)
	$[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$	0	.159*	(13)
		18	.20	(1)
		20	.26	(2)
		46.6	.477*	(13)
(NH_3)	$\left\{ \begin{array}{l} \text{" } \\ \text{" } \\ \text{" } \end{array} \right\} \begin{array}{l} \text{Br}_3 \\ \text{I}_3 \\ \text{F}_3 \end{array}$	18	.04	(1)
		18	.015	(1)
		20	.00273	(3)
		40	.00864	
		60	.01243	
		80	.01546	
		100	.01664	
	$[\text{" }](\text{NO}_3)_3$	0	.0202	(2)
		18	.033	(1)
		20	.052	(2)
		30	.075	(3)
	$[\text{" }](\text{IO}_3)_2$	0	.00181	(2)
		18	.00389	(26)
		20	.00458	(2)
	$[\text{" }]_2(\text{SO}_4)_3$	25	.00527	(5)
		0	.0090	(2)
		18	.015	(1)
		20	.020	(2)
		25	.0286	(3)
		35	.0336	(6)
		45	.0462	(3)
	$\left\{ \begin{array}{l} \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \end{array} \right\} \begin{array}{l} (\text{ReO}_4)_3 \\ (\text{ClO}_3)_3 \\ (\text{ClO}_4)_3 \\ {}_2(\text{CrO}_4)_3 \\ {}_2(\text{Cr}_2\text{O}_7)_3 \\ {}_2(\text{C}_2\text{O}_4)_3 \\ \text{PO}_4 \\ [\text{O}-\text{C}_6\text{H}_2(\text{NO}_2)_3]_3 \text{ (picrate)} \\ [\text{C}_{10}\text{H}_7\text{SO}_3]_3 \text{ (}\beta\text{ naphthalene sulfonate)} \\ [\text{Fe}(\text{CN})_6] \end{array}$	20	.000515	(29)
		18	.215	(1)
		18	.013	(1)
		18	.00055	(1)
		18	.00029	(1)
		18	.00069	(1)
		18	.00055	(1)
		18	.00042	(1)
		18	.00059	(1)
		0	.000009	(2)
		20	.000016	(2)
		25	.00003	(7)(8)
	$\left\{ \begin{array}{l} \text{" } \\ \text{" } \\ \text{" } \end{array} \right\} \begin{array}{l} \text{ClSO}_4 \\ [\text{Cr}(\text{CN})_6] \\ [\text{Co}(\text{CN})_6] \end{array}$	0	.01055	(2)
		0	.000028	(2)
		0	.000007	(2)
		18	.00001375	(11)
		20	.000016	(2)
		25	.000022	(8)
	$\left\{ \begin{array}{l} \text{" } \\ \text{" } \\ \text{" } \\ \text{" } \end{array} \right\} \begin{array}{l} [\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]_3 \\ [\text{Co}(\text{C}_2\text{O}_4)_3] \\ [\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]_3 \\ [\text{Co}(\text{NH}_3)_2\text{NO}_2\text{C}_2\text{O}_4]_3 \end{array}$	0	.000043	(2)
		0	.000019	(2)
		25	.000164	(8)(9)
		15	.0000492	(10)
		20	.0000642	(10)
		25	.0000827	(8)(9)
	$\left\{ \begin{array}{l} \text{" } \\ \text{" } \end{array} \right\} \begin{array}{l} [\text{Co}(\text{NO}_2)_6] \\ [\text{C}_6\text{H}_{10}\text{NSO}_3]_3 \end{array}$	ordinary	.0000434	(12)
		20	.0037	(14)

*Moles per 1000 gme. H_2O

SOLUBILITY OF LUTEO COBALTIC SULFATE IN AQUEOUS
SOLUTIONS OF SULFURIC ACID AT 35°
(Sakar and Barat, 1930)

Gms. H ₂ SO ₄ per 100 gms. aq. solvent	Gm. Co per 100 gm. sat. sol.	Solid Phase
0.0	0.4013	[Co(NH ₃) ₆] ₂ (SO ₄) ₃
0.75	0.7041	"
1.5	1.1121	"
2.0	1.2806	"
2.3	1.2063	[Co(NH ₃) ₆] ₂ (SO ₄) ₃ ·H ₂ SO ₄
3.0	1.0911	"
5.0	0.8103	"
7.5	0.7540	"
10.0	0.7472	"
15.00	0.7827	"
17.1	0.7196	[Co(NH ₃) ₆] ₂ (SO ₄) ₃ ·2H ₂ SO ₄
20.0	0.5217	"
30.0	0.1632	"
40.0	0.1125	"
50.0	0.1760	"
60.0	0.4629	"
61.0	0.4037	2[Co(NH ₃) ₆] ₂ (SO ₄) ₃ ·5H ₂ SO ₄ ·10H ₂ O
62.0	0.3208	"
65.0	0.1980	"
70.0	0.0980	"
75.0	0.0512	"
80.0	0.0415	"

Benrath (1926) and Benrath and Wurzburger, (1924) give data for the solubility of hexammines in aqueous solutions of HCl, KCl, HgCl₂, H₂SO₄ and HNO₂. Double compounds are formed in some cases.

COBALT PENTAMMINES ["PURPUREO" = [Co(NH₃)₅X]⁺⁺] (NH₃)
 ["ROSEO" = [Co(NH₃)₅(H₂O)]⁺⁺⁺]
 ["XANTHO" = [Co(NH₃)₅NO₂]⁺⁺]

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
[Co(NH ₃) ₅ SO ₄]NO ₃	20	0.026	(2)
[Co(NH ₃) ₅ I]Cl ₂	20	0.0154	(17)
" SO ₄	20	0.00529	(17)
" (ClO ₃) ₂	20	0.00244	(17)
" (NO ₃) ₂	20	0.00217	(17)
" I ₂	20	0.0020	(17)
" Br ₂	20	0.00076	(17)
" [O·C ₆ H ₂ (NO ₂) ₃] ₂	20	0.00005	(17)

Co COBALT

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
[Co(NH ₃) ₅ Cl]Br ₂	0	.00725	(2)
	14.3	.0137	(13)
	19	.0178	(17)
	20	.0161	(16)
["]Cl ₂	0	.00914	(2)
		(.00898)	(18)
		(.00928)	(13)
	15.5	.0164	(13)
	18	.0170	(26)
	19	.0170	(17)
	20	.01785	(2)(16)
	29.7	.0242	(18)
	46.6	.0412	(13)
	50	.0401	(18)
["]I ₂	19	.0462	(13)
		(.0418)	(17)
	20	.0464	(16)
["](IO ₃) ₂	0	.00200	(2)
	18	.00378	(26)
["]PtCl ₆	0	.000091	(2)
["](NO ₃) ₂	15	.0412	(13)
	19	.0434	(17)
	20	.046	(2)(16)
["]C ₂ O ₄	0	.00036	(2)
	18	.000745	(26)
	19	.00074	(17)
["]SO ₄	17.3	.0241	(13)
	19	.0344	(17)
	20	.029	(2)
	25	.0412	(3)
["][Co(NH ₃) ₂ (NO ₂) ₄] ₂	0	.000173	(2)
	20	.000637	(2)
["](ClO ₄) ₂	19	.0917	(17)
["]Cr ₂ O ₇	19	.0059	(17)
["]SiF ₆	19	.00111	(17)
["][C ₁₀ H ₇ SO ₃] ₂ ·6H ₂ O	19	.00126	(17)
["]S ₂ O ₃	19	.00102	(17)
	20	.002751	(24)
["]CrO ₄	19	.00041	(17)
["][O·C ₆ H ₂ (NO ₂) ₃] ₂	19	.00017	(17)
{ Co(NH ₃) ₅ Br } (ClO ₄) ₂ ·H ₂ O	20	.0837	(17)
["]SO ₄	20	.0246	(17)
["](NO ₃) ₂	20	.0107	(17)
		(.0102)	(2)(16)
["]Cl ₂	0	.00542	(2)
	20	.0108	(2)(16)(17)
["]I ₂	20	.0101	(17)
		(.0138)	(16)
["]Br ₂	0	.00275	(2)
	16	.0050	(13)
	20	.00614	(17)
		(.0060)	(16)
["]SiF ₆	20	.00278	(17)
["][C ₁₀ H ₇ SO ₃] ₂ ·6H ₂ O	20	.0007	(17)

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
$[\text{Co}(\text{NH}_3)_5\text{Br}]\text{C}_2\text{O}_4$	20	.0005	(17)
" CrO_4	20	.0004	(17)
" $[\text{O} \cdot \text{C}_6\text{H}_2(\text{NO}_2)_3]_2$	20	.0003	(17)
$\text{Co}(\text{NH}_3)_5\text{SO}_4$	20	.2881	(15)
" I	20	.0371	(15)
" $\text{C}_6\text{H}_2\text{N}_3\text{O}_7 \cdot 2\text{H}_2\text{O}$	20	.00169	(15)
" 2CrO_4	20	.0103	(15)
" $2\text{Cr}_2\text{O}_7$	20	.00534	(15)
" ClO_3	20	.0661	(15)
" ClO_4	20	.0364	(15)
" 2SiF_6	20	.1461	(15)
" 2SO_4	20	.3464	(15)
" Br	20	.0500	(15)
" NO_3	20	.0273	(15)
$\text{Co}(\text{NH}_3)_5(\text{HCOO})](\text{ClO}_4)_2$	20	.124	(28)
$\text{Co}(\text{NH}_3)_5(\text{CH}_3\text{COO})](\text{ClO}_4)_2$	20	.0403	(28)
$\text{Co}(\text{NH}_3)_5(\text{ClCH}_2\text{COO})](\text{ClO}_4)_2$	20	.0305	(28)
$\text{Co}(\text{NH}_3)_5(\text{Cl}_2\text{CHCOO})](\text{ClO}_4)_2$	20	.0342	(28)
$\text{Co}(\text{NH}_3)_5(\text{Cl}_3\text{CCOO})](\text{ClO}_4)_2$	20	.0685	(28)
$\text{Co}(\text{NH}_3)_5(\text{C}_2\text{H}_5\text{COO})](\text{ClO}_4)_2$	20	.0697	(28)
$\text{Co}(\text{NH}_3)_5(\text{n} \cdot \text{C}_3\text{H}_7\text{COO})](\text{ClO}_4)_2$	20	.149	(28)
$\text{Co}(\text{NH}_3)_5(\text{i} \cdot \text{C}_3\text{H}_7\text{COO})](\text{ClO}_4)_2$	20	.138	(28)
$\text{Co}(\text{NH}_3)_5(\text{n} \cdot \text{C}_4\text{H}_9\text{COO})](\text{ClO}_4)_2$	20	.260	(28)
$\text{Co}(\text{NH}_3)_5(\text{i} \cdot \text{C}_4\text{H}_9\text{COO})](\text{ClO}_4)_2$	20	.174	(28)
$\text{Co}(\text{NH}_3)_5((\text{CH}_3)_3\text{CCOO})](\text{ClO}_4)_2$	20	.281	(28)
$\text{Co}(\text{NH}_3)_5(\text{n} \cdot \text{C}_5\text{H}_{11}\text{COO})](\text{ClO}_4)_2$	20	.216	(28)
$\text{Co}(\text{NH}_3)_5(\text{n} \cdot \text{C}_7\text{H}_{15}\text{COO})](\text{ClO}_4)_2$	20	.0742	(28)
$[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$	19	.1064	(17)
" CrO_4	20	.1078	(2) (16)
" CrO_4	0	.000258	(2)
" CrO_4	19	.00062	(17)
" $(\text{NO}_3)_2$	20	.000547	(2)
" $(\text{NO}_3)_2$	0	.0170	(2)
" $(\text{NO}_3)_2$	19	.0368	(17)
" $(\text{NO}_3)_2$	20	.038	(2)
" $(\text{NO}_3)_2$		(.0396)	(16)
" $(\text{NO}_3)_2$		(.033)	(30)
" C_2O_4	0	.000161	(2)
" C_2O_4	19	.00042	(17)
" C_2O_4	20	.000432	(2)
" $[\text{Co}(\text{NH}_3)_2(\text{NO}_3)_4]_2$	0	.00031	(2)
" $[\text{Co}(\text{NH}_3)_2(\text{SCN})_4]_2$	20	.00099	(2)
" $[\text{Co}(\text{NH}_3)_2(\text{SCN})_4]_2$	0	.000392	(2)
" $[\text{Co}(\text{NH}_3)_2(\text{SCN})_4]_2$	20	.0001284	(2)
" Br_2	19	.0436	(17)
" Br_2	20	.046	(16)
" $[\text{I}_2]_{\text{[hairy]}}$	19	.0945	(17)
" $[\text{I}_2]_{\text{[octahed.]}}$	19	.0846	(17)
" $[\text{I}_2]_{\text{[octahed.]}}$	20	.097	(16)
" $(\text{ClO}_4)_2$	19	.0525	(17)
" SO_4	19	.0442	(17)
" SiF_6	19	.00259	(17)
" Cr_2O_7	19	.0018	(17)
" $(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 3\text{H}_2\text{O}$	19	.00073	(17)

(NH₃)

Co COBALT

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
[Co(NH ₃) ₅ NO ₂](O·C ₆ H ₂ (NO ₂) ₃) ₂	19	0.00050	(17)
[Co(NH ₃) ₅ NO ₃](ClO ₃) ₂	18	.0970	(17)
["] Cl ₂	18	.0279	(17)
["] (ClO ₄) ₂	20	.0331	(16)
["] I ₂	18	.0278	(17)
["] I ₂	18	.0271	(17)
["] Br ₂	20	.0338	(16)
["] Br ₂	18	.0159	(17)
["] (NO ₃) ₂	20	.0260	(16)
(NH ₃) ["] (NO ₃) ₂	16	.011	(13)
["] (NO ₃) ₂	18	.0122	(17)
["] (NO ₃) ₂	20	.010	(16)
["] SO ₄	18	.0050	(17)
["] C ₂ O ₄	18	.0043	(17)
["] SiF ₆	18	.0038	(17)
["] Cr ₂ O ₇	18	.00103	(17)
["] [C ₁₀ H ₇ SO ₃] ₂ ·3H ₂ O	18	.00086	(17)
["] CrO ₄	18	.00061	(17)
["] [O·C ₆ H ₂ (NO ₂) ₃] ₂	18	.00059	(17)
[Co(NH ₃) ₅ H ₂ O]Cl ₃	0	.602	(13)
["] Cl ₃	16.2	.928	(13)
["] Cl ₃	17.5	.859	(17)
["] Br ₃	17.5	.346	(17)
["] (ClO ₄) ₃	17.5	.207	(17)
["] I ₃	17.5	.155	(17)
["] (NO ₃) ₃	17.5	.153	(17)
["] ₂ (SO ₄) ₃	17.5	.047	(17)
["] ₂ (CrO ₄) ₃	17.5	.0019	(17)
["] [C ₁₀ H ₇ SO ₃] ₃ ·3H ₂ O	17.5	.00064	(17)
["] ₂ (Cr ₂ O ₇) ₃	17.5	.00037	(17)
["] [O·C ₆ H ₂ (NO ₂) ₃] ₃	17.5	.00024	(17)
["] [Fe(CN) ₆]	0	.000172	(2)
["] [Fe(CN) ₆]	20	.00370	(24)
["] ₂ (SO ₄) ₃	20	.016	(2)
["] [Cr(NH ₃) ₂ (SCN) ₄] ₃	0	.00006	(2)
["] F ₃	18	.0269	(3)
["] F ₃	40	.0609	(3)
["] F ₃	75	.1156	(3)
["] F ₃	100	.1572	(3)
[Co(NH ₃) ₅ Rh]SO ₄	0	.01177	(2)
[Co(NH ₃) ₅ SCN]Cl ₂	20	.039	(2)
["] CrO ₄	0	.00107	(2)
["] I ₂	25	.00088	(21)
["] (IO ₃) ₂	20	.00505	(2)
["] (NO ₃) ₂	25	.003444	(21)
["] SO ₄	20	.0290	(2)
[Co(NH ₃) ₅ (OCONH ₂)]Br ₂	20	.630	(27)
["] SO ₄	20	.220	(27)
["] (NO ₃) ₂	20	.0779	(27)
["] I ₂	20	.1885	(27)
["] S ₂ O ₆	20	.000501	(27)
[Co(NH ₃) ₅ N ₃]Cl	20	.0492	(31)
["] NO ₃	20	.0197	(31)
["] Br	20	.0288	(31)
["] I	20	.0329	(31)

Benrath (1926) and Benrath and Wurzburger (1924) give data for the solubility of various pentamines in aqueous solutions of HCl, KCl, HgCl₂, H₂SO₄ and HNO₃. Double compounds are formed in some cases.

SOLUBILITY OF SEVERAL PENTAMMINES IN METHANOL AT 20°
(Bronsted, Delbanco and Volquartz, 1932)

Formula	Moles per liter sat. sol. in CH ₃ OH	Formula	Moles per liter sat. sol. in CH ₃ OH
[Co(NH ₃) ₅ Cl]Cl ₂	0.000052	[Co(NH ₃) ₅ NO ₃]Cl ₂	0.000065
" " Br ₂	0.000084	" " Br ₂	0.000098
" " I	0.0011	" " I ₂	0.00048
" " (NO ₃) ₂	0.000286	" " (NO ₃) ₂	0.000048
[Co(NH ₃) ₅ Br]Cl ₂	0.000043	[Co(NH ₃) ₅ NO ₂]Cl ₂	0.0002
" " Br ₂	0.0000466	" " Br ₂	0.00018
" " I ₂	0.000391	" " I ₂	0.0018
" " (NO ₃) ₂	0.000093	" " (NO ₃) ₂	0.000231

The solubility of cobalt chloro pentamine sulfate, [Co(NH₃)₅Cl]SO₄, in aqueous solutions of sulfuric acid at 35° and at 50° is reported by Liou Qui Tao and Wang Shik Mo, 1936. The analytical results are not given but it is stated that they do not agree with those of Benrath, 1926. The solid phases up to a concentration of 1.5 mol. H₂SO₄ per liter is [Co(NH₃)₅Cl]SO₄·2H₂O, and at concentration from 1.8 to 5.0 mol. H₂SO₄ it is [Co(NH₃)₅Cl]SO₄· $\frac{1}{3}$ H₂SO₄·2H₂O.

COBALT TETRAMMINES ["CROCEO" = trans [Co(NH₃)₄(NO₂)₂]*] (NH₃)
["FLAVO" = cis [Co(NH₃)₄(NO₂)₂]*]

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
[Co(NH ₃) ₄ CO ₃] ₂ [Co(SCN) ₄ SO ₄]	20	0.070	(2)
" "] ₂ [Co(SCN) ₄ CrO ₄]	0	.00185	(2)
" "] ₂ [Co(SCN) ₄ CrO ₄]	20	.00555	(2)
" "] ₂ [Co(NH ₃) ₂ (NO ₂) ₄]	0	.00366	(2)
trans[Co(NH ₃) ₄ (NO ₂) ₂]Br	20	.0124	(2)
" " "]Cl	0	.012	(2)
" " "]Cl	18	.0268	(17)
" " "]Cl	20	.0281	(16)
" " "]Cl	0	.0222	(2)
" " "]Cl	18	.0397	(17)
" " "]Cl	20	.043	(2)
" " "]Cl		(.0441)	(16)
" [Co(NH ₃) ₄ (NO ₂) ₃][Co(NH ₃) ₂ (C ₂ O ₄) ₂]	0	.000066	(2)
" [Co(NH ₃) ₄ (NO ₂) ₂][Co(NH ₃) ₃ (C ₂ O ₄) ₂]	0	.00059	(2)
" "] ₂ PtCl ₆	0	.00233	(2)
" "] ₂ ClO ₄	0	.0124	(2)
" " "]Cl	18	.0242	(17)
" " "]Cl	20	.0290	(2)

Co COBALT

Formula				t°	Moles salt per liter sat. sol.	Author (p. 823)
trans	[Co(NH ₃) ₄ (NO ₂) ₂]	[C ₆ H ₂ O(NO ₂) ₃]		20	0.00704	(2)
"	"	SeO ₄		20	.0092	(2)
"	"	SO ₄		0	.00096	(2)
				15	.00171	(25)
				18	.00364	(17)
				20	.00411	(2)
					(.00249)	(16)
				25	.002447	(5)
					(.00244)	(25)
(NH ₃)	"	"	AuCl ₄	20	.017	(2)
"	"	"	[Co(NH ₃) ₂ (NO ₂) ₄]	0	.000096	(2)
"	"	"	[Cr(NH ₃) ₂ (SCN) ₄]	20	.000355	(20)
"	"	"		0	.000057	(2)
"	"	"		20	.000143	(2)
"	"	"	KClO ₃	18	.0253	(17)
"	"	"		20	.0292	(16)
"	"	"	H	18	.0198	(17)
"	"	"		20	.0185	(16)
"	"	"	Cr ₂ O ₇	18	.0160	(17)
"	"	"	NO ₃	α* 0	.00546	(22)
				α 20	.01483	(22)
				β* 0	.00501	(22)
				β 5	.00645	(22)
				β 10	.00821	(22)
				β 15	.01040	(22)
				β 20	.01306	(22)
				(18)	(0.0119)	(17)
"	"	"	SiF ₆	18	.0110	(17)
"	"	"	O·C ₆ H ₂ (NO ₂) ₃	18	.00561	(17)
"	"	"	CrO ₄	18	.00310	(17)
"	"	"	BrO ₃	20	.0162	(16)
"	"	"	IO ₃	20	.0291	(16)
"	"	"	CH ₃ COO	20	.0412	(16)
"	"	"	C ₂ H ₅ COO	20	.0252	(16)
"	"	"	C ₃ H ₇ COO	20	.1280	(16)
"	"	"	Cl(CH ₃ COO)	20	.0190	(16)
"	"	"	Br(CH ₃ COO)	20	.0331	(16)
"	"	"	I(CH ₃ COO)	20	.116	(16)
"	"	"	[Co(NO ₂) ₄]	20	.000352	(16)
"	"	"	C ₆ H ₂ O(NO ₂) ₂ (picrate)	20	.0061	(16)
"	"	"	C ₆ H ₄ CHCOO	20	.0411	(16)
"	"	"	C ₆ H ₄ NO ₂ COO(meta)	20	.0203	(16)
"	"	"	[Co(NH ₃) ₂ (NO ₂) ₄]	20	.000352	(16)
				?	.000802	(12)

*This salt exists in two modifications. The more stable of these is the β modification. It is a light brown crystal powder while the α modification consists of citrine needle shaped crystals. Both varieties have one molecule of water of crystallization.

Data are also given for the solubility of the two forms of this compound in a large number of aqueous salt solutions. (Brönsted, 1919, 1922)

Formula	t°	Moles salt per liter sat. sol.	Author (p. 823)
$[\text{Co}(\text{NH}_3)_4\text{NO}_2\text{SCN}]\text{Cl}$	20	0.00337	(16)
" " Br	20	.0541	(16)
" " ClO_4	20	.0248	(16)
" " $[\text{Co}(\text{NO}_2)_4]$	20	.00184	(16)
" " $\text{C}_6\text{H}_5\text{O}(\text{NO}_2)_2$	20	.000615	(16)
$\text{cis}[\text{Co}(\text{NH}_3)_4(\text{NO}_2)_2]\text{Cl}$	20	.034	(2)
" "	23	.260	(17)
" " Br	23	.193	(17)
" " NO_3	23	.132	(17)
" " I	23	.090	(17) (NH_3)
" " ClO_4	23	.0586	(17)
" " $\text{C}_{10}\text{H}_7\text{SO}_3$	23	.00895	(17)
" " 2SiF_6	23	.00725	(17)
" " 2SO_4	15	.00241	(25)
" "	23	.00725	(17)
" "	25	.00364	(25)
" " $2\text{Cr}_2\text{O}_7$	23	.00332	(17)
" " 2CrO_4	23	.00258	(17)
" " $\text{O}\cdot\text{C}_6\text{H}_2(\text{NO}_2)_3$	23	.00158	(17)
" " $[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]$	0	.000949	(2)
" "	20	.0033	(2)
" "		(.00325)	(16)
" ["] $[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$	α ?	.00741	(12)
" "	0	.000749	(2)
" "	20	.00100	(2)
" ["] ["]	β 0	(.001389)	(24)
" "	20	.000322	(2)
" ["] $\text{C}_6\text{H}_7\text{SO}_3$	20	.00073	(20)
$[\text{Co}(\text{NH}_3)_4(\text{C}_2\text{O}_4)]_3[\text{Cr}(\text{SCN})_6]$	20	.00895	(30)
" " NO_3	0	.00053	(2)
" "	0	.0066	(2)
" "	20	.018	(2)
" " IO_3	18	.00822	(26)
" " ClO_4	0	.0051	(2)
" "	20	.0140	(2)
" "		(.0146)	(23)
" " $3[\text{Co}(\text{C}_2\text{O}_3)_3]$	0	.00083	(2)
" " SO_4	25	.0147	(23)
" " Cr_2O_7	25	.00110	(23)
" " CrO_4	25	.000579	(23)
" " $[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]$	0	.00103	(2)
" " ["] (cis)	20	.00325	(16)
" "		(.00037)	(5)
" " $[\text{Cr}(\text{NH}_3)_2(\text{CNS})_4]$	20	.00139	(19)
" " $[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2\text{C}_2\text{O}_4]$	20	.00067	(19)
" " $2\text{S}_2\text{O}_8$	20	.000755	(19)
" " $2\text{S}_2\text{O}_6$	20	.000201	(19)
$\text{Co}(\text{NH}_3)_4(\text{SCN})(\text{NO}_2)[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2(\text{C}_2\text{O}_4)]$	20	.000449	(19)
$[\text{Co}(\text{NH}_3)_4(\text{SCN})][\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]$	20	.00184	(16)
$[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Br}$	0	.00632	(2)
" " ClO_3	0	.0180	(2)
" " Cl	0	.0141	(2)
" " $[\text{Co}(\text{C}_2\text{O}_4)_2(\text{NH}_3)_2]$	0	.000171	(2)

Co COBALT

	Formula	t°	Moles salt per liter sat. sol.	Author (p. 283)
(NH ₃)	[Co(NH ₃) ₄ Cl ₂] ₃ [Fe(CN) ₆]	0	0.000121	(2)
	" " IO ₃	0	.00441	(2)
	" " NO ₃	0	.00383	(2)
	" " C ₆ H ₂ O(NO ₃) ₃	0	.00021	(2)
	" " SCN	0	.00289	(2)
	Co(NH ₃) ₄ (H ₂ O)Cl ₂	0	.052	(2)
	Co(NH ₃) ₄ (H ₂ O) ₂ Cl ₃	22	1.83	(17)
	" " Br ₃	22	1.67	(17)
	" " (NO ₃) ₃	22	1.03	(17)
	" " 2(SO ₄) ₃	22	0.1752	(17)
	" " C ₁₀ H ₇ SO ₃ · 3 · 6H ₂ O	22	0.007	(17)
	Co(NH ₃) ₄ H ₂ O(SO ₄) ₂ · 4H ₂ O	20	.1254	(20)
	" " Cl	20	.2726	(20)
	" " ClO ₄	20	.1508	(20)
	" " NO ₃	20	.0712	(20)
	" " Br	20	.0677	(20)
	" " C ₆ H ₂ N ₃ O ₇	20	.0093	(20)
	[Co(NH ₃) ₄ (CO ₃)]SO ₄	25	.214	(23)
	cis[Co(NH ₃) ₄ (ClCH ₂ COO) ₂]ClO ₄	20	.170	(28)
	" [Co(NH ₃) ₄ (Cl ₂ CHCOO) ₂]ClO ₄	20	.092	(28)
	" [Co(NH ₃) ₄ (Cl ₃ CCOO) ₂]ClO ₄	20	.038	(28)
	trans[Co(NH ₃) ₄ (ClCH ₂ COO) ₂]ClO ₄	20	.0222	(28)

SOLUBILITY OF SEVERAL COBALT TETRAMINES IN METHANOL AT 20°
(Brönsted, Delbanco and Volquartz, 1932)

	Formula	Moles per liter sat. sol. in CH ₃ OH
trans	[Co(NH ₃) ₄ (NO ₂) ₂]Cl	0.000602
"	" " Br	0.001145
"	" " I	0.001126
"	" " ClO ₃	0.00061
"	" " BrO ₃	0.00012
"	" " IO ₃	0.00170
"	" " CH ₃ COO	0.000372
"	" " C ₂ H ₅ COO	0.00036
"	" " C ₃ H ₇ COO	0.00194
"	" " 2Cl(CH ₃ COO)	0.00039
"	" " 2Br(CH ₃ COO)	0.000675
"	" " 2I(CH ₃ COO)	0.00331
"	" " [Co(NO ₂) ₄]	0.0000322
"	" " C ₆ H ₂ O(NO ₂) ₂	0.0019
"	" " C ₆ H ₄ OHCOC	0.00631
"	" " C ₆ H ₄ NO ₂ COO	0.0027
"	" " 2SO ₄	0.000015
"	" " [Co(NH ₃) ₂ (NO ₂) ₄]	0.000322
"	" " [Co(NH ₃) ₂ (NO ₂) ₄]	0.000192
cis	[Co(NH ₃) ₄ SCN(NO ₂)] [Co(NH ₃) ₂ (NO ₂) ₄]	0.000192
"	" " Cl	0.00117
"	" " Br	0.00307
"	" " ClO ₄	0.00453
"	" " [Co(NO ₂) ₄]	0.000354
"	" " C ₆ H ₂ O(NO ₂) ₂	0.00542

Data for the solubility of Nitro Rhodano Tetrammine Cobalt Chloride, $[\text{Co}(\text{NH}_3)_4\text{NO}_2(\text{SCN})]\text{Cl}$, in aqueous 0.1 normal solutions of HCl , LiCl , NaCl , KCl and CsCl are given by Gütelberg and Pederson, 1926. This compound was chosen even though it could not be prepared completely pure, just as is the case with the larger number of metal ammoniates. Also, it is not completely stable in solution. It was found that the solubility increases with time of rotation about 1 per cent per hour. From determinations after various periods of rotation the solubility at 0 time of rotation was estimated to be 0.012 gm. mols. per 1000 gms. H_2O at 20° .

COBALT DIAMMINES

 (NH_3)

Formula	t°	Moles per liter sat. sol.		Author (p. 823)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{K}$	0	0.0240	in H_2O	(2)
"	20	.0651	"	(16)
"	20	.00338	in CH_3OH	(16)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{Rb}$	20	.0250	in H_2O	(16)
"	20	.00117	in CH_3OH	(16)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{Cs}$	0	.00531	in H_2O	(2)
"	20	.0170	"	(16)
"		(.01720)	"	(2)
"	20	.000815	in CH_3OH	(16)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_3]$	20	.00593	in H_2O	(16)
"	20	.00066	in CH_3OH	(16)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{Ag}$	0	.000772	in H_2O	(2)
"	20	.00210	"	(2)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{Ti}$	0	.00251	in H_2O	(2)
"	20	.00789	"	(2)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2\text{C}_2\text{O}_4]\text{Ag}$	0	.00278	in H_2O	(2)
"	20	.00822	"	(2)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2\text{C}_2\text{O}_4]\text{Ti}$	0	.00420	in H_2O	(2)
"	20	.00977	"	(2)
$[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4](\text{CH}_3)_4\text{N}$	0	.00749	in H_2O	(2)
"	20	.0197	"	(2)

The solubility of the Croceo Salt (Trans-) Tetranitrodiammino Cobaltate in solutions of the corresponding Leuto Salt (cis-) and NaCl at 18° is given by Brönsted and Williams, 1928.

COBALT HEXACYANIDES

CN

HEXA CYANO COBALTIC ACID, METHYL ALCOHOLATE AND ETHYL ALCOHOLATE
SOLUBILITY OF EACH SEPARATELY IN METHYL AND IN ETHYL ALCOHOL
(Holzl, 1931)

The compounds were prepared by conducting dry hydrochloric acid gas into an absolute methyl or ethyl alcohol solution of Hexa cyano cobaltic acid $[\text{Co}(\text{CN})_6]\text{H}_3$. The crystalline precipitates thus obtained had the compositions respectively: $[\text{Co}(\text{CN})_6]\text{H}_3 \cdot 2\text{CH}_3\text{OH}$ and $[\text{Co}(\text{CN})_6]\text{H}_3 \cdot 3\text{C}_2\text{H}_5\text{OH}$.

(Cont.)

Co COBALT

Results for the methyl alcoholate
in commercial and in abs. CH_3OH Results for the ethyl
alcoholate in abs. $\text{C}_2\text{H}_5\text{OH}$

	Gms. salt per 100 cc sat. sol.		t°	Gms. salt per 100 cc sat. sol.		t°	Gms. Alcoholate per 100 cc sat. sol. in $\text{C}_2\text{H}_5\text{OH}$
	a	b		a	b		
-10	28.2	-	25	79.9	60.4	0	2.47
- 5	34.1	-	35	94.5	-	25	3.99
- 2	40.9	-	45	116.0	80.5	45	6.29
0	-	35.8	53	140.0	-	55	7.27
CN + 5	49.9	-	60	180.0	-	65	9.50
15	64.3	-	65	207.0	120.0	75	12.68

a = commercial abs. methyl alcohol

b = CH_3OH boiled and distilled from CaO Solid Phase = $\text{Co}(\text{CN})_6\text{H}(\text{HOHCH}_3)_2$ in all cases.

Solid Phase =

 $[\text{Co}(\text{CN})_6]\text{H}_2 \cdot 3\text{C}_2\text{H}_5\text{OH}$ in
all cases.THE SYSTEM DICYANO-BIS-ETHYLENE DIAMINE COBALTIC SULFATE -
COPPER SULFATE - WATER AT 30°
(Sarma, 1951)

Gms. per 100 gms. sat. sol.		Solid Phase
$[\text{Co}(\text{CN})_2(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2]_2\text{SO}_4$	CuSO_4	
2.51	0.0	$\text{X}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$
2.86	1.09	"
3.07	1.89	"
3.62	2.50	"
3.90	2.76	" + 1:1:4
3.66	2.74	1:1:4
3.28	2.86	"
2.75	3.24	"
2.48	3.81	"
2.36	5.89	"
2.38	7.52	"
2.45	9.76	"
2.51	11.63	"
2.51	14.01	"
2.48	20.89	" + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
2.33	20.85	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
2.08	20.59	"
1.96	20.25	"
1.47	20.44	"
1.08	20.22	"
0.57	19.94	"
0.0	19.66	"

 $\text{X} = [\text{Co}(\text{CN})_2(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2]$ 1:1:4 = $[\text{Co}(\text{CN})_2(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2]_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 4\text{H}_2\text{O}$

COBALT NITRITE $\text{Co}(\text{NO}_2)_2$

NO

SOLUBILITY OF COBALT NITRITE IN WATER
(Le Boucher, 1926)

t°	Gms. $\text{Co}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $\text{Co}(\text{NO}_2)_2$ per 100 gms. sat. sol.	Solid Phase
0	0.076	?	20	0.40	?
5	0.15	"	25	0.49	"
10	0.24	"	30	0.60	"
15	0.32	"	40	0.84	"

COBALT RUBIDIUM NITRITE $\text{Rb}_3\text{Co}(\text{NO}_2)_6 \cdot \text{N}_2\text{O}$ 100 gms. H_2O dissolve 0.005 gm. of the salt. (Rosenblatt, 1886)COBALT NITRATE $\text{Co}(\text{NO}_3)_2$

NO

SOLUBILITY IN WATER

[Funk, 1900; Wilcox and Bailey, 1927 (a); Cuvelier, 1931 (b); Waldman
and Klutchko-Gourvitch, 1935 (c); Katzin and Ferraro, 1950 (d);
Gorshtein and Silant'eva, 1954 (e)]

t°	Gms. $\text{Co}(\text{NO}_3)_2$ per 100 Gms. Solution	Gms. $\text{Co}(\text{NO}_3)_2$ per 100 Mols. H_2O	Solid Phase
-26	39.45	6.40	$\text{Co}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$
-20.5	42.77	7.35	"
-21	41.55	6.98	$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-10	43.69	7.64	"
-4	44.85	7.99	"
0	45.66	8.26	"
+15	47.7	- (a)	"
18	49.73*	9.71	"
20	49.33	- (a)	"
	49.7	- (b)	"
	48.5	- (e)	"
25	50.7	- (a)	"
	50.57	- (c)	"
	50.36	- (d)	"
30	52.7	- (a)	"
41	55.96	12.5	"
56	62.88	16.7	"
55	61.74	15.8	$\text{Co}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
62	62.88	16.7	"
70	64.89	18.2	"
80	67.86	- (c)	"
84	68.84	21.7	"
91	77.21	33.3	"

*Density of solution saturated at 18° = 1.575.

Co COBALT

SOLUBILITY OF COBALT NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID
(Waldman and Klatchko-Gourvitch, 1935)

Results at 25°

Results at 80°

	Results at 25°			Results at 80°		
	Gms. HNO ₃ per 100 gms. aq. solvent	Gms. Co(NO ₃) ₂ per 100 gms. sat. sol.	Solid Phase	Gms. HNO ₃ per 100 gms. aq. solvent	Gms. Co(NO ₃) ₂ per 100 gms. sat. sol.	Solid Phase
NO	0.0	50.57	Co(NO ₃) ₂ ·6H ₂ O	0.0	67.86	Co(NO ₃) ₂ ·3H ₂ O
	1.25	49.37	"	2.53	67.40	"
	2.41	47.90	"	3.85	67.28	"
	6.15	44.88	"	5.15	67.64	"
	14.05	38.00	"	6.20	66.10	"
	19.76	34.02	"	8.67	64.80	"
	24.81	30.00	"	9.50	63.82	"
	30.87	26.87	"	10.27	63.68	"

THE SYSTEM COBALT NITRATE - COPPER NITRATE - WATER
(Wilcox and Bailey, 1927)

d ₂₀ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Co(NO ₃) ₂	Cu(NO ₃) ₂	
Results at 14°			
-	47.5	0.0	Co(NO ₃) ₂ ·6H ₂ O
-	44.3	5.2	"
-	28.7	25.8	"
-	22.8	34.1	"
-	19.0	36.5	1.6.42
-	16.7	34.8	"
-	16.0	38.9	"
-	14.0	41.5	"
-	11.1	45.6	Cu(NO ₃) ₂ ·6H ₂ O
-	5.9	47.0	"
-	0.0	52.5	"

Results at 20°

1.598	49.3	0.0	Co(NO ₃) ₂ ·6H ₂ O
1.610	41.2	9.9	"
1.613	38.9	13.1	"
1.640	34.2	20.3	"
1.705	24.5	33.7	"
1.773	17.9	43.1	"
-	16.7	45.0	"
-	10.8	49.4	Cu(NO ₃) ₂ ·6H ₂ O
1.707	8.9	49.8	"
-	0.0	55.6	"

1.6.42 = Co(NO₃)₂·6Cu(NO₃)₂·42H₂O.

(Cont.)

THE SYSTEM COBALT NITRATE - COPPER NITRATE - WATER--Contd.

d ₂₀ of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Co(NO ₃) ₂	Cu(NO ₃) ₂	
	Results at 30°		
-	52.7	0.0	Co(NO ₃) ₂ ·6H ₂ O
-	44.7	9.2	"
-	29.2	27.1	"
-	22.2	37.9	"
-	16.5	45.7	Cu(NO ₃) ₂ ·6H ₂ O
-	13.0	48.4	"
-	5.3	54.9	"
-	0.0	61.4	"

NO

THE SYSTEM COBALT NITRATE - NICKEL NITRATE - WATER AT 20°
(Gorshtein and Silant'eva, 1954)

The salts form discontinuous hexahydrated solid solutions.

Saturated Solution Wt. %		Solid Phase Wt. %	
Co(NO ₃) ₂ ·6H ₂ O	Ni(NO ₃) ₂ ·6H ₂ O	Co(NO ₃) ₂ ·6H ₂ O	Ni(NO ₃) ₂ ·6H ₂ O
77.07	0.0	100	0.0
75.17	0.88	94.26	0.83
75.55	0.90	95.79	0.79
75.42	0.85	96.33	0.80
72.82	2.66	93.22	2.53
73.60	2.67	92.60	2.63
73.23	3.84	91.35	4.06
72.64	4.10	91.63	3.98
68.94	8.03	88.05	7.70
69.25	8.02	88.92	7.82
69.72	8.03	88.74	7.71
69.40	8.02	88.06	7.86
62.02	13.70	79.67	13.83
61.95	13.67	80.81	14.15
49.71	26.74	68.46	26.76
49.80	25.97	67.54	27.23
38.11	38.85	53.34	42.23
38.84	39.59	55.37	43.67
30.81	47.49	43.71	52.97
30.88	47.54	43.94	52.86
26.15	51.43	36.53	56.61
25.98	51.29	35.39	58.25
24.44	53.83	36.22	61.12
24.34	53.84	35.68	60.43
24.70	54.32	17.37	78.14
25.16	53.45	17.89	77.38
14.84	63.49	9.91	87.73
14.53	63.11	9.99	84.70
14.51	62.47	10.03	86.81
8.82	69.02	5.63	90.94
8.78	69.01	5.57	90.74
4.71	73.84	2.96	95.06
4.76	73.80	3.03	94.38
2.08	73.30	1.39	93.36
2.09	72.74	1.47	92.74
0.0	76.21	0.0	0.0

Co COBALT

THE SYSTEM COBALT NITRATE - ACETONE - WATER AT 25°
(Katzin and Ferraro, 1950)

Gms. per 100 gms. sat. sol.

	H ₂ O	Co(NO ₃) ₂	Solid Phase
	48.68	50.36	Co(NO ₃) ₂ ·6H ₂ O
	44.45	48.98	"
	36.83	46.39	"
	27.04	43.54	"
	25.83	43.01	Co(NO ₃) ₂ ·6H ₂ O + Co(NO ₃) ₂ ·4H ₂ O
	25.83	42.99	"
NO	23.86	42.94	"
	20.41	41.00	"
	20.28	41.34	"
	16.41	40.38	"
	13.93	39.83	Co(NO ₃) ₂ ·4H ₂ O
	13.06	39.38	"
	11.55	42.44	"
	9.17	47.14	"
	8.90	46.88	"
	8.73	47.00	"
	8.66	49.37	"
	8.58	49.05	Co(NO ₃) ₂ ·4H ₂ O + Co(NO ₃) ₂ ·3H ₂ O
	8.68	49.12	"
	8.54	49.26	"
	8.95	49.94	"
	8.92	50.00	"
	8.45	50.05	"
	8.79	51.44	Co(NO ₃) ₂ ·3H ₂ O
	7.89	52.83	"
	7.98	52.35	Co(NO ₃) ₂ ·3H ₂ O + Co(NO ₃) ₂ ·2H ₂ O
	7.67	52.37	"
	8.15	52.51	"
	8.27	52.93	"
	8.00	53.10	"
	8.43	53.84	"
	7.92	56.01	Co(NO ₃) ₂ ·2H ₂ O
	6.65	57.32	"
	6.39	57.00	"
	6.38	56.54	"
	5.94	56.11	"
	5.34	55.04	Co(NO ₃) ₂ ·2H ₂ O + Co(NO ₃) ₂ ·2(CH ₃ COCH ₃)(?)
	5.29	55.14	"
	3.57	50.39	"

THE SYSTEM COBALT NITRATE - t-BUTANOL - WATER AT 25°
(Katzin and Ferraro, 1950)

Gms. per 100 gms. sat. sol.			
H ₂ O	Co(NO ₃) ₂	Solid Phase	
47.11	48.93	Co(NO ₃) ₂ ·6H ₂ O	
44.51	45.67	"	
26.97	27.54	"	
11.44	16.88	"	
10.16	15.61	"	
10.22	15.71	Co(NO ₃) ₂ ·6H ₂ O + Co(NO ₃) ₂ ·4H ₂ O·2(CH ₃) ₃ COH	NO
10.06	15.65	"	
8.17	15.38	"	
7.85	15.22	"	
7.65	15.23	"	
7.15	15.71	Co(NO ₃) ₂ ·4H ₂ O·2(CH ₃) ₃ COH	
6.64	17.19	"	
6.66	18.47	"	
6.41	19.59	"	
6.22	21.42	"	
6.61	23.74	Co(NO ₃) ₂ ·4H ₂ O·2(CH ₃) ₃ COH + Co(NO ₃) ₂ ·3H ₂ O·3(CH ₃) ₃ COH	
6.83	23.81	"	
6.21	23.58	Co(NO ₃) ₂ ·3H ₂ O·3(CH ₃) ₃ COH	
5.86	23.50	Co(NO ₃) ₂ ·3H ₂ O·3(CH ₃) ₃ COH	
5.88	23.06	Co(NO ₃) ₂ ·3H ₂ O·3(CH ₃) ₃ COH + Co(NO ₃) ₂ ·2H ₂ O·4(CH ₃) ₃ COH	
5.87	22.92	"	
5.59	22.91	"	
5.49	22.71	"	
5.46	22.60	Co(NO ₃) ₂ ·2H ₂ O·4(CH ₃) ₃ COH	
5.45	23.13	"	
4.98	20.66	"	
4.87	20.01	"	
4.77	17.83	Co(NO ₃) ₂ ·2H ₂ O·4(CH ₃) ₃ COH + Co(NO ₃) ₂ ·4(CH ₃) ₃ COH(?)	
4.57	17.58	"	
4.00	17.80	"	
3.89	17.53	"	
3.65	16.27	Co(NO ₃) ₂ ·4(CH ₃) ₃ COH(?)	
3.85	12.35	"	
3.07	17.73	"	
1.19	8.49	"	
0.40	8.09	"	

Co COBALT

DISTRIBUTION OF COBALT NITRATE BETWEEN n-HEXANOL AND WATER AT 25° (Templeton and Daly, 1951)

Weight Percentages

Aqueous Phase		Alcoholic Phase	
Co(NO ₃) ₂	H ₂ O	Co(NO ₃) ₂	H ₂ O
51.2	48.6	12.84*	8.18*
44.9	55.8	7.50	7.08
43.8	55.3	6.55	6.56
41.2	57.5	4.12	5.84
NO 36.2	61.7	2.48	5.11

*Saturated with Co(NO₃)₂·6H₂O

DISTRIBUTION OF COBALT NITRATE BETWEEN BUTYL ACETATE AND WATER (Levashova, Darienko and Degtyarev, 1955)

Distribution coefficients for cobalt (organic/aqueous) in the presence of NH₄SCN.

t° (±1°)	2N NH ₄ SCN	4N NH ₄ SCN	8N NH ₄ SCN
0	2.75	13.8	52.5
16	1.38	5.6	31.6
26	0.478	3.16	16.6

SOLUBILITY OF COBALT NITRATE IN ORGANIC SOLVENTS

Ether at 15° A solution saturated with Co(NO₃)₂·6H₂O contains 0.1 gms. Co(NO₃)₂. (Bachelet, Cheylan and LeBris, 1950)

Glycol "100 grams saturated solution contain 80 gms. cobalt nitrate." (de Coninck, 1905)

NO COBALT Pyridine NITRATE Co(NO₂)₃·3C₅H₅N

100 gms. sat. solution of Co(NO₂)₃·3C₅H₅N in pyridine contain 0.20 gm. Co at 0°, 0.29 gm. at 10°, 0.40 gm. at 20° and 0.49 gm. at 25°. (LeBoucher, 1926)

COBALTOUS OXIDE CoO
 COBALTOUS HYDROXIDE Co(OH)_2

O
OH

SOLUBILITY IN WATER

Okca, 1940 found the solubility to be 1.4×10^{-5} moles per liter by potentiometric titration at room temperature. Gayer and Garrett report between 1 and 3×10^{-5} moles Co(OH)_2 dissolved per liter at 25° .

Nasanen, 1943 found the thermodynamic solubility product to be 1.3×10^{-15} by potentiometric determinations in potassium chloride Solutions.

SOLUBILITY OF Co(OH)_2 IN SOLUTIONS OF NaOH and KOH

(Results of Arkipov, Pakahver and Podbornova, 1950)		(Results of Gayer and Garrett, 1950)		(Results of Gordon and Schreyer, 1952)		
(15°)		(25°)		Alkali metal hydroxide, molarity	Solubility of cobalt (II) in milligrams per liter	
Gms. per liter		Moles per 1000 gms. H ₂ O		NaOH	KOH	
		NaOH	Co(OH) ₂			
NaOH	Co	0.01	5 x 10 ⁻⁷	12	374	511
		.05	8 x 10 ⁻⁷	11	328	374
		.24	1.8 x 10 ⁻⁷	10	241	268
		.57	3.7 x 10 ⁻⁶	9	200	172
		1.57	9.2 x 10 ⁻⁶	8	144	138
		4.69	5.8 x 10 ⁻⁴	7	94.0	93.0
86.4	0.57	.24	1.8 x 10 ⁻⁷	6	63.0	56.0
120.2	1.57	.55	3.7 x 10 ⁻⁶	5	44.4	38.2
169.2	4.69	.89	9.2 x 10 ⁻⁶	4	24.2	20.8
209.2	9.26	4.95	5.8 x 10 ⁻⁴	3	11.8	10.2
		9.70	5.1 x 10 ⁻³			

SOLUBILITY OF Co(OH)_2 IN HCL SOLUTIONS AT 25° (Gayer and Garrett, 1950)

The final HCL concentrations were a_{H^+} read from a pH meter.

Moles per 1000 gms. H_2O			Moles per 1000 gms. H_2O		
HCL			HCL		
Initial	Final	Co(OH)_2	Initial	Final	Co(OH)_2
0.0	0.51×10^{-8}	1.3×10^{-5}	0.074	9.55×10^{-8}	3.85×10^{-2}
.003	2.69 "	1.5×10^{-3}	.100	10.5 "	5.2×10^{-2}
.005	3.02 "	2.6×10^{-3}	.130	10.7 "	6.8×10^{-2}
.01	4.68 "	4.8×10^{-3}	.160	11.5 "	8.0×10^{-2}
.03	7.41 "	11.5×10^{-3}	.170	11.7 "	8.7×10^{-2}
.05	8.32 "	24×10^{-3}			

Melting point data are given for:

$\text{CoO} + \text{CoS}$, FeS , SiO_2 . (Asanti and Kohlmeier, 1951)
 $\text{CoO} + \text{B}_2\text{O}_3$ (Berger, 1949)

Co COBALT

OH COBALTIC HYDROXIDE Co(OH)_3

1000 cc ordinary distilled H_2O , containing a little CO_2 , dissolve 0.00318 gm. Co(OH)_3 at 20° . (Almkvist, 1918)

The activity product $K_{sp} = 3.2 \times 10^{-45}$ at 19° and 3.2×10^{-44} at 81° . (Sobol, 1953)

S COBALT SULFIDE CoS

Goates, Gordon and Faux, 1952 calculated the solubility product of CoS from free energy data and found it to be 8×10^{-23} . Kapustinsky, 1940 gives 3.1×10^{-23} . His calculated solubilities at various pH values are as follows:

pH	3	5	7	9	11
Moles CoS per liter	5.4×10^{-4}	5.4×10^{-6}	7.7×10^{-8}	5.6×10^{-9}	5.6×10^{-10}

Donges, 1947 determined the solubility of Cobalt Sulfide as a function of the method of washing, time of exposure to air, and reagents used.

1000 cc aq. 2.0 normal H_2SO_4 , saturated with H_2S at 1 atmosphere pressure dissolve 0.0156 gm. CoS at 20° . (Moser and Behr, 1924)

Melting point data are given for:

$\text{Co} + \text{S}$	}	Schenck and von der Forst, 1942
$\text{CoS} + \text{NiS}$		
$\text{CoS} + \text{FeS}$		Vogel and Hillner, 1953
$\text{CoS} + \text{FeS}$	}	Asanti and Kohlmeier, 1951
$\text{CoS} + \text{FeO}$		
$\text{Co}_4\text{S}_3 + \text{FeS}$	}	Vogel and Au, 1949
$\text{Co}_6\text{S}_5 + \text{FeS}$		

SH COBALT HYDROSULFIDE Co(SH)_2

One liter of water saturated with cobalt dihydrosulfide contain 0.00021 gm. Co(SH)_2 at about 20° . (Mickwitz, 1931)

COBALT Hydroxy HYDROSULFIDE Co(SH)(OH)

One liter of water saturated with cobalt hydroxy sulfhydrate contain 0.00005 gm. Co(SH)(OH) at about 20° . (Mickwitz, 1931)

SOLUBILITY IN WATER

The results of various authors are not in very good agreement. The most extensive investigation is that of Rohmer (1939) and includes the metastable region above 64.2° . The data of Koppel, Wetzel (1905) Benrath and Tiemann (1934) are about 1% higher below 50° . Those of Klatchko-Gourvitch and Gandganov (1934) agree with Rohmer at 0° and 80° , but with the higher values at 20° and 40° . Other authors are similarly divided.

The unmarked data below are those of Rohmer (1939); those in parentheses () are a composite of Koppel, Wetzel (1905); Benrath and Tiemann (1934); Benrath (1931).

Gms. CoSO_4 per 100 gms. t° sat. sol.			Gms. CoSO_4 per 100 gms. t° sat. sol.		
		Solid Phase			Solid Phase
-0.9	9.0	Ice	80.4	40.5	$\text{CoSO}_4 + \text{CoSO}_4 \cdot 4\text{H}_2\text{O}$
-1.4	12.6	"	80	40.15 b	$\text{CoSO}_4 \cdot 4\text{H}_2\text{O}$
-2.1	16.2	"	83	40.8*	"
-2.7	18.8 (19.03)	" + $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$	84	40.8*	"
0	19.8 (20.3)	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$	90.4	41.5*	"
	19.82 c	"	94.8	42.1*	"
	19.55 b	"	101	43.2*	"
10	23.7 (23.4)	"	72.9	38.9	" + $\text{CoSO}_4 \cdot 2\text{H}_2\text{O}$
12.5	24.52 a	"	77	38.9*	$\text{CoSO}_4 \cdot 2\text{H}_2\text{O}$
15	24.2	"	78	38.9*	"
20	25.6 (26.5)	"	80	38.8*	"
	26.5 b	"	88	38.8*	"
25	27.2 (28.0)	"	93	38.7*	"
	27.35 d	"	96	38.7*	"
	27.33 e	"	61.3	37.5*	$\text{CoSO}_4 \cdot \text{H}_2\text{O}$
	27.16 c	"	64.2	36.7	" + $\text{CoSO}_4 \cdot 6\text{H}_2\text{O}$
30	28.7 (29.6)	"	66	36.4	$\text{CoSO}_4 \cdot \text{H}_2\text{O}$
35	30.3	"	70	35.4	"
40	31.5 (32.8)	"	75	- (36.7)	"
	32.75 b	"	80	33.0 (35.0)	"
43.3	37.9 (34.0)	" + $\text{CoSO}_4 \cdot 6\text{H}_2\text{O}$	90	30.3 (31.2)	"
50	33.8 (34.25)	$\text{CoSO}_4 \cdot 6\text{H}_2\text{O}$	97	34.33 f	"
60.2	35.9 (35.5)	"	100	27.8 (28.0)	"
64.2	36.7*	"	101.2 (b.pt.)	27.2	"
65	37.0*	"	115	47 g	"
70.4	38.2* (38.2)	"	135	45 g	"
75.8	39.5*	"	153	41.5 g	"
78	40.0*	"	170	37.2 g	"
80	40.4*	"	185	30 g	"
83.8	41.4*	"	205	20 g	"
87.8	42.3*	"	205	10 g	"
90.0	43.0*	"	205	5 g	"
95	44.6*	"			

*Metastable

^aMonte-marynini and Losana, 1928; ^bKlatchko-Gourvitch and Gandganov, 1935; ^cCrockford and Brawley, 1932; ^dCaven and Johnston, 1928, also Caven and Gardner, 1933; ^eBassett and Henshall, 1950; ^fBenrath and Benrath, 1929; ^gBenrath, 1941.

Co COBALT

SOLUBILITY OF COBALT SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID

The results of Monte-marynini and Losana, 1928 (12°), Klatchko-Gourvitch and Gandganov, 1935, (0°, 20°, 40°, 80°) and Rohmer, 1939 (0°, 25°, 40°, 70°, 78°) are in general agreement as to the compositions of the saturated solutions, but the nature of the equilibrium solid phase is disputed. Rohmer questions the accuracy of the earlier results of Klatchko-Gourvitch and Gandganov, 1935, due to the short time (4 hours) allowed for attainment of equilibrium and errors of the method of analysis. He also finds that the tetra hydrate and tri hydrate of cobalt sulfate do not exist as stable solid phases.

50	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	H ₂ SO ₄	CoSO ₄		H ₂ SO ₄	CoSO ₄	

Results at 0°

(Rohmer, 1939)			(K-G, and G., 1935)		
0.0	19.8	CoSO ₄ ·7H ₂ O	0.0	19.55	CoSO ₄ ·7H ₂ O
9.9	13.2	"	2.78	17.73	"
19.3	8.2	"	5.94	16.10	"
29.0	5.4	"	11.88	11.40	"
33.6	4.6	"	20.78	7.86	"
42.0	4.0	" + CoSO ₄ ·6H ₂ O	35.03	4.04	"
42.0	3.9	CoSO ₄ ·H ₂ O + "	41.14	3.62	CoSO ₄ ·6H ₂ O
44.1	3.1	"	49.14	3.01	"
51.5	0.9	"	50.9	2.95	CoSO ₄ ·3H ₂ O
55.1	0.3	"	51.1	2.64	"
91.4	0.0	" + CoSO ₄	60.21	1.86	"
5.2	45.6*	CoSO ₄ ·7H ₂ O	70.43	0.988	"
7.3	49.3*	"			
3.9	42.0*	CoSO ₄ ·6H ₂ O			
4.6	47.1*	"			
5.3	49.3*	"			

*Metastable

*Metastable

Results at 12.5° (Monte-marynini and Losana, 1928)

Density	Gms. per 100 gms. sat. sol.		Solid Phase
	H ₂ SO ₄	CoSO ₄	
1.2832	0.0	24.52	CoSO ₄ ·7H ₂ O
1.2703	9.88	16.94	"
1.2782	21.56	11.08	CoSO ₄ ·6H ₂ O
1.3186	27.72	9.96	"
1.3276	31.26	9.86	"
1.3680	39.67	6.98	" + CoSO ₄ ·H ₂ O
1.3825	47.92	3.24	CoSO ₄ ·2H ₂ O
1.4614	56.21	1.06	" + CoSO ₄
1.5451	65.72	0.24	CoSO ₄
1.6426	73.48	0.04	"
1.7652	84.51	0.25	CoSO ₄ ·H ₂ SO ₄
1.8448	98.80	0.68	"

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H ₂ SO ₄	CoSO ₄	Solid Phase	H ₂ SO ₄	CoSO ₄	Solid Phase
Results at 20°			Results at 25°		
(K-G, and G., 1935)			(Rohmer, 1939)		
0.0	26.5	CoSO ₄ ·7H ₂ O	0.0	27.1	CoSO ₄ ·7H ₂ O
2.43	23.76	"	5.2	22.8	"
7.1	20.55	"	9.4	20.4	"
10.2	18.6	"	16.8	16.7	"
18.01	14.5	"	20.8	15.0	"
20.9	13.55	"	22.5	14.6	" + CoSO ₄ ·6H ₂ O
21.3	12.98	"	23.8	13.9	CoSO ₄ ·6H ₂ O
24.2	11.9	"	30.2	11.3	"
26.8	11.2	"	31.0	11.0	" + CoSO ₄ ·H ₂ O
29.18	10.22	CoSO ₄ ·6H ₂ O	40.7	4.3	CoSO ₄ ·H ₂ O
32.0	9.45	"	43.7	3.0	"
34.4	8.9	"	47.2	1.6	"
37.86	8.3*	"	50.6	0.9	"
39.2	8.3*	"	54.1	0.4	"
41.27	8.95*	"	76.4	0.0	"
41.8	9.25*	"	89.6	0.0	" + CoSO ₄
37.6	7.36	CoSO ₄ ·3H ₂ O	97.0	0.0	CoSO ₄
38.5	6.13	"	35.5	10.3*	CoSO ₄ ·6H ₂ O
42.7	3.7	"	38.4	10.8*	"
44	3.1	"	39.8	11.9*	"
48.9	1.8	"			
Results at 40°					
(K.G. & G., 1935)			(Rohmer, 1939)		
0.0	32.75	CoSO ₄ ·7H ₂ O	0.0	31.5	CoSO ₄ ·7H ₂ O
3.56	29.65	"	2.4	29.6	"
8.74	25.98	"	3.6	28.9	" + CoSO ₄ ·6H ₂ O
10.52	25.04	"	7.0	26.7	CoSO ₄ ·6H ₂ O
15.7	25.17*	"	10.8	24.5	"
7.7	27.5*	CoSO ₄ ·6H ₂ O	15.6	21.8	"
13.71	22.97	"	22.1	18.9	" + CoSO ₄ ·H ₂ O
19.67	20.13	"	23.9	16.7	CoSO ₄ ·H ₂ O
21.93	19.2	"	28.3	13.1	"
24.85	18.2	"	33.1	9.3	"
30.48	16.8	"	41.8	4.0	"
34.72	13.62	CoSO ₄ ·3H ₂ O	47.0	1.8	"
35.8	11.03	"	86.3	0.0	" + CoSO ₄
37.8	7.2	"	96.1	0.0	CoSO ₄
39.9	5.0	"	23.4	18.3*	CoSO ₄ ·6H ₂ O
50.8	1.06	CoSO ₄ ·H ₂ O	31.6	17.4*	"
54.6	0.74	"	25.9	17.6*	CoSO ₄ ·4H ₂ O
58.75	0.32	"	26.0	17.6*	CoSO ₄ ·2H ₂ O

(Cont.)

*Metastable

Co COBALT

30	Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
	H ₂ SO ₄	CoSO ₄	Solid Phase	H ₂ SO ₄	CoSO ₄	Solid Phase
	Results at 70° (Rohmer, 1939)			Results at 80° (K-G and G, 1935)		
	0.0	35.2	CoSO ₄ ·H ₂ O	0.0	40.15	CoSO ₄ ·4H ₂ O
	5.1	30.6	"	0.68	39.2	"
	16.6	21.5	"	2.9	37.08	" + CoSO ₄ ·3H ₂ O
	30.0	10.3	"	4.32	31.67	CoSO ₄ ·3H ₂ O
	41.3	3.7	"	7.55	26.75	"
	52.0	0.2	"	11.57	23.51	"
	79.8	0.0	" + CoSO ₄	17.7	20.6	"
	96.1	0.0	CoSO ₄	19.8	20.4	" + CoSO ₄ ·H ₂ O
	0	38.0*	CoSO ₄ ·6H ₂ O	20.8	19.5	CoSO ₄ ·H ₂ O
	5.3	34.5*	"	26.89	14.4	"
	9.2	32.8*	" + CoSO ₄ ·4H ₂ O	28.7	13.2	"
	12.6	30.3*	CoSO ₄ ·4H ₂ O	32.57	10.3	"
	2.6	36.3*	CoSO ₄ ·6H ₂ O + CoSO ₄ ·2H ₂ O	39.25	5.09	"
	9.7	30.1*	CoSO ₄ ·2H ₂ O	44.4	4.4	"
	13.5	27.0*	"			
	17.0	24.3*	"			

Results at 78° (Rohmer, 1939)

0.0	34.0	CoSO ₄ ·H ₂ O	4.7	37.0*	CoSO ₄ ·6H ₂ O
12.1	25.3	"	6.4	35.7*	CoSO ₄ ·4H ₂ O
0.0	39.3*	CoSO ₄ ·6H ₂ O	11.3	32.2*	"
7.0	36.0*	"	0.0	39.8*	CoSO ₄ ·2H ₂ O
0.0	40.4*	CoSO ₄ ·4H ₂ O	13.9	29.1*	"

*Metastable

THE SYSTEM COBALT SULFATE - COBALT OXIDE - WATER AT 18° (Gromov, 1948)

CoSO ₄ Wt. %	Co gms. per liter	Density	pH	Solid Phase
24.8	120.1	1.278	6.60	CoO·CoSO ₄ ·xH ₂ O + CoSO ₄ ·7H ₂ O
11.7	50.2	1.130	6.99	CoO·CoSO ₄ ·H ₂ O
6.7	27.4	1.073	7.10	"
2.48	9.7	1.030	7.26	"
1.47	5.7	1.019	7.34	"
0.91	3.5	1.015	7.38	"
0.52	2.0	1.010	7.49	"
0.0	0.0	1.000	8.5	Co(OH) ₂

THE SYSTEM COBALT SULFATE - COPPER SULFATE - WATER
(Crockford and Brawley, 1932)

Results at 0°

Results at 25°

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CoSO ₄	CuSO ₄	Solid Phase	CoSO ₄	CuSO ₄	Solid Phase
19.82	0.0	CoSO ₄ ·7H ₂ O	27.16	0.0	CoSO ₄ ·7H ₂ O
19.09	0.59	Solid Solution	25.24	1.76	Solid Solution
17.64	1.57	"	23.25	3.71	"
15.02	3.14	"	18.55	7.45	"
10.67	6.66	"	15.03	11.61	"
7.89	9.53	"	13.88	12.91	" + CuSO ₄ ·5H ₂ O
5.94	11.95	" + CuSO ₄ ·5H ₂ O	9.70	14.68	CuSO ₄ ·5H ₂ O
4.05	12.33	CuSO ₄ ·5H ₂ O	5.07	16.66	"
2.80	12.55	"	1.14	18.18	"
1.00	12.78	"	0.0	18.45	"
0.0	12.87	"			

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THE SYSTEM COBALT SULFATE - FERROUS SULFATE - WATER AT 20°
(Gorshtein and Silanteva, 1953)

The solid phase is a continuous heptahydrated solid solution.

Saturated Solution wt. %			Saturated Solution wt. %		
CoSO ₄ ·7H ₂ O	FeSO ₄ ·7H ₂ O	Wt. % in solid phase	CoSO ₄ ·7H ₂ O	FeSO ₄ ·7H ₂ O	Wt. % in solid phase
48.16	0.0	0.0	25.71	15.45	41.85
38.81	3.77	10.46	13.89	25.71	68.79
38.80	3.81	10.51	14.29	25.89	68.45
34.92	8.54	22.65	8.09	29.67	81.32
27.68	13.84	37.33	8.00	29.47	81.38
27.97	13.59	37.35	0.0	37.05	100.0

THE SYSTEM COBALT SULFATE - POTASSIUM SULFATE - WATER
(Results of Caven and Johnston, 1928 at 25°)

Gm. mols. per 1000 gms. H ₂ O		Solid Phase	Gm. mols. per 1000 gms. H ₂ O		Solid Phase
K ₂ SO ₄	CoSO ₄		K ₂ SO ₄	CoSO ₄	
0.0	2.433	CoSO ₄ ·7H ₂ O	0.388	0.950	1.1.6
0.190	2.536	"	0.531	0.458	"
0.212	2.557	" + 1.1.6	0.780	0.239	" + K ₂ SO ₄
0.240	2.205	1.1.6	0.737	0.150	K ₂ SO ₄
0.321	1.372	"	0.680	0.00	"
0.361	1.095	"			

(Cont.)

Co COBALT

Results of Benrath, 1932 and Benrath and Ritter, 1939 at various temperatures:

t°	Gms. per 100 gms. H ₂ O		Solid Phase	t°	Gms. per 100 gms. H ₂ O		Solid Phase
	K ₂ SO ₄	CoSO ₄			K ₂ SO ₄	CoSO ₄	
0	7.27	1.23	K + 1.1.6	55	15.75	8.15	K + 1.1.6
"	2.45	20.3	Co7 + 1.1.6	60	13.0	11.56	Co6 + 1.1.6
"	4.12	3.67	1.1.6	68	4.55	37.2	Co6 + Col + 1.1.6
25	11.55	3.14	K + 1.1.6	69	5.4	37.0	Col + 1.1.6
"	2.57	27.65	Co7 + 1.1.6	75	26.1	19.70	K + 1.1.6
30	7.73	6.88	1.1.6	"	21.3	25.95	1.1.6
38	16.22	5.73	K + 1.1.6	"	12.58	59.3	Col + 1.1.6
"	8.65	15.75	1.1.6	80	10.11	31.49	Col + 1.1.6
"	5.8	31.0	Co7 + 1.1.6	88	16.84	20.41	K + 1.1.6
39	2.87	33.0	Co7 + Co6 + 1.1.6	"	13.45	26.45	Col + 1.1.6
40	13.99	4.88	K + 1.1.6	94	15.27	23.05	Col + K + 1.1.6
46	3.45	33.15	Co6 + 1.1.6	96	31.4	38.0	K + 1.1.6
"	11.08	9.87	1.1.6	"	28.1	41.3	1.1.6
50	18.21	8.63	K + 1.1.6	"	26.2	48.9	Col + 1.1.6
"	15.47	13.30	1.1.6	100	17.8	24.67	Col + K
"	5.5	52.7	Co6 + 1.1.6				

K = K₂SO₄; Co6 = CoSO₄·6H₂O; Co7 = CoSO₄·7H₂O; 1.1.6 = CoSO₄·K₂SO₄·6H₂O
Co 1 = CoSO₄·H₂O

SOLUBILITY OF COBALT POTASSIUM SULFATE IN WATER (Benrath, 1932)

t°	Gms. CoK ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. CoK ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. CoK ₂ (SO ₄) ₂ per 100 gms. H ₂ O
0	8.5	30	19.4	60	32.5
10	11.7	40	23.4	70	38.7
20	15.5	50	27.7	80	47.8
25	15.80 ^a				

^aHill, Durham and Ricci, 1940 (density = 1.128)

THE SYSTEM CoK₂(SO₄)₂ - CuK₂(SO₄)₂ - H₂O Results at 25° (Hill, Durham, and Ricci, 1940)

Each point is the average of two closely agreeing results, one of which was obtained by dissolving the Cobalt Salt completely before adding the Copper Salt, and the second of which was obtained by reversing the order of addition of the salts. The solid solutions are of Roozeboom's Type I.

(Cont.)

THE SYSTEM $\text{CoK}_2(\text{SO}_4)_2 - \text{CuK}_2(\text{SO}_4)_2 - \text{H}_2\text{O}$ —Contd.
Results at 25°

Saturated Solution		Solid Phase	
Wt. % $\text{CoK}_2(\text{SO}_4)_2$	Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{CoK}_2(\text{SO}_4)_2$	Wt. % $\text{CuK}_2(\text{SO}_4)_2$
13.65	0.0	-	-
11.73	1.318	63.13	12.13
9.72	2.963	48.45	26.96
7.62	4.61	34.40	41.00
5.38	6.29	21.85	53.65
2.917	8.21	10.07	65.48
0.0	10.35	-	-

30

Data of Ploinowna, 1926
Results at 0°

d. of sat. sol.	Gms. per 1000 cc sat. sol.		Per cent Co salt in Solid Phase
	$\text{CoK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{CuK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	
1.0719	106.81	0.0	100.00
1.0673	87.06	11.40	78.59
1.0612	65.31	25.43	59.15
1.0601	56.68	31.19	50.54
1.0566	44.15	39.48	41.26
1.0538	33.30	46.32	30.33
1.0524	22.09	53.71	18.40
1.0488	13.46	58.33	10.96
1.0462	0.00	67.67	0.00

Results at 77.8°

1.0879	133.80	0.00	100.00
1.0852	124.47	5.90	90.44
1.0825	110.20	14.79	79.60
1.0796	94.53	25.30	70.25
1.0760	82.36	32.18	58.73
1.0730	73.90	37.08	52.87
1.0703	58.54	46.92	40.47
1.0668	44.62	56.02	29.16
1.0639	29.49	66.14	20.11
1.0617	17.21	74.48	12.22
1.0587	0.00	85.99	0.00

Co COBALT

THE SYSTEM COBALT SULFATE - AMMONIUM SULFATE - WATER
Data of Craven and Gardner (1933) at 25°

	Gm. mols. per 1000 gms. H ₂ O		Solid Phase	Gm. mols. per 1000 gms. H ₂ O		Solid Phase
	CoSO ₄	(NH ₄) ₂ SO ₄		CoSO ₄	(NH ₄) ₂ SO ₄	
	2.441	0.0	CoSO ₄ ·7H ₂ O	0.9069	0.4655	1.1.6
	2.430	0.2868	" + 1.1.6	0.5916	0.5989	"
	2.352	0.3156	1.1.6	0.1581	1.375	"
	1.744	0.3522	"	0.0967	2.534	"
	1.678	0.3986	"	0.0606	3.061	"
SO	1.054	0.4488	"	0.0370	4.689	"
	0.9419	0.4677	"	0.00	5.826	(NH ₄) ₂ SO ₄

1.1.6 = CoSO₄·(NH₄)₂SO₄·6H₂O

Data of Benrath (1932) at several temperatures.

t°	Gms. per 100 gms. H ₂ O		Solid Phase	t°	Gms. per 100 gms. H ₂ O		Solid Phase
	CoSO ₄	(NH ₄) ₂ SO ₄			CoSO ₄	(NH ₄) ₂ SO ₄	
0	0.28	40.95	1.1.6 + (NH ₄) ₂ SO ₄	55	12.60	10.73	1.1.6
0	4.80	4.09	1.1.6	55	34.02	4.14	" + Co6
0	19.33	2.12	" + Co7	68	35.68	5.05	" + " + Col
25	0.16	43.9	1.1.6 + (NH ₄) ₂ SO ₄	80	2.02	47.75	" + (NH ₄) ₂ SO ₄
25	7.40	6.28	1.1.6	80	17.45	14.85	1.1.6
25	27.23	2.76	" + Co7	80	31.82	7.94	" + Col
39	35.75	3.38	" + " Co6	100	4.76	47.5	" + (NH ₄) ₂ SO ₄
46	35.0	4.04	" + Co6	100	23.18	19.72	"
55	0.70	46.4	" + (NH ₄) ₂ SO ₄	100	26.58	12.48	" + Col

1.1.6 = CoSO₄·(NH₄)₂SO₄·6H₂O; Co7 = CoSO₄·7H₂O; Co6 = CoSO₄·6H₂O;
 Col = CoSO₄·H₂O

SOLUBILITY OF COBALT AMMONIUM SULFATE IN WATER
 (Benrath, 1932)

The averages of the older determinations of Locke (1901), Toblev (1855) and von Haver (1858) are given in parentheses.

t°	Gms. Co(NH ₄) ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. Co(NH ₄) ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. Co(NH ₄) ₂ (SO ₄) ₂ per 100 gms. H ₂ O
0	9.8 (6.0)	40	23.1 (22.0)	80	47.7 (49.0)
10	12.5 (9.5)	50	27.7 (27.0)	90	58.0
20	15.5 (13.0)	60	33.5 (33.5)	100	75.1
30	19.0 (17.0)	70	39.5 (40.0)		

THE SYSTEM $\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{H}_2\text{O}$
(Bertischowra, 1926)

d. of sat. sol.	Gms. per 1000 cc sat. sol.		Per cent Co salt in solid phase
	$\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	

Results at 0°

1.0646	111.65	0.00	100.00
1.0687	101.36	16.14	90.06
1.0758	77.68	50.70	69.14
1.0809	56.92	80.87	52.86
1.0836	49.49	92.28	43.22
1.0863	35.53	110.93	32.80
1.0886	22.56	127.89	24.13
1.0905	15.70	138.11	14.27
1.0931	0.0	162.82	0.00

SO

Results at 8°

1.0757	130.78	0.00	100.00
1.0757	112.78	27.76	85.68
1.0846	105.76	40.45	77.29
1.0923	77.75	82.50	57.91
1.0960	69.22	96.99	48.76
1.0985	51.75	120.61	36.42
1.1027	34.93	144.14	25.91
1.1059	28.44	157.65	18.44
1.1094	12.09	178.04	9.43
1.1112	0.00	197.62	0.00

THE SYSTEM $\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{H}_2\text{O}$ AT 20°
(Gorshstein and Silanteva, 1954)

[continuous hexahydrated solid solutions are formed]

Gms. per 100 gms. sat. sol.		Per cent $\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ in solid phase
$\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	
16.70	0.0	0.0
15.66	0.47	8.91
15.22	0.71	13.7
15.08	0.68	13.7
14.05	1.19	21.8
13.97	1.16	22.0
10.31	2.30	39.6
4.82	5.19	77.4
4.11	5.35	78.2
3.30	5.68	85.7
3.28	5.69	85.5
1.97	7.16	92.0
1.97	7.34	91.4
1.55	7.38	93.7
1.61	7.40	93.6
0	8.45	100.00

Co COBALT

THE SYSTEM $\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{H}_2\text{O}$ AT 20°
(Gorshtein and Silanteva, 1954)

[continuous hexahydrated solid solutions are formed]

S0	Gms. per 100 gms. sat. sol.		Per cent $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ in solid phase
	$\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{Co}(\text{NH}_3)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	
	0.0	16.70	0.0
	1.89	14.08	4.09
	1.89	14.02	4.06
	4.29	13.26	9.68
	4.29	13.26	9.66
	6.94	11.90	16.44
	6.92	11.92	15.64
	16.60	6.02	46.56
	16.47	5.83	46.18
	18.37	4.99	53.92
	18.41	5.03	54.22
	28.75	0.0	100.00

THE SYSTEM COBALT SULFATE - SODIUM SULFATE - WATER
Results at 25°

(in good agreement)

Craven and Gardner, 1933

Bassett and Henshall, 1950

Gm. mols. per 1000 gms. H_2O		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CoSO_4	Na_2SO_4		CoSO_4	Na_2SO_4	
2.433	0.00	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$	0.0	21.80	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
2.406	0.1983	"	5.50	21.05	"
2.372	0.4220	"	9.66	20.13	"
2.327	0.7565	"	12.19	20.06	"
2.275	1.075	" + 1:1.4	14.14	19.37	" + 1:1:4
2.266	1.096	1:1.4	13.25	18.68*	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
1.891	1.356	"	13.80	17.98	1:1:4
1.665	1.663	"	15.90	16.05	"
1.517	2.035	"	19.70	12.85	"
1.510	2.092	" + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	22.78	10.51	"
1.119	2.069	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	23.30	10.68	"
0.750	2.044	"	23.40	10.53	" + $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$
0.0	1.988	"	24.72	7.41	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$
			25.90	4.39	"
			26.05	2.85	"
			27.33	0.0	"

1:1:4 = $\text{CoSO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$

* metastable

(Cont.)

THE SYSTEM COBALT SULFATE - SODIUM SULFATE - WATER--Contd.
(Benrath and Benrath, 1929)
Results at 97°

d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	CoSO ₄	Na ₂ SO ₄			CoSO ₄	Na ₂ SO ₄	
1.408	34.33	0.0	CoSO ₄ ·H ₂ O	1.368	20.48	14.00	1.1.4
1.409	31.21	2.96	"	1.340	17.84	15.94	"
1.395	27.21	7.09	"	1.332	14.96	18.89	"
1.372	23.10	11.40	"	-	11.43	22.23	"
1.448	28.91	9.01	" + (?)	1.318	0.38	27.65	" + Na ₂ SO ₄
1.424	28.13	10.34	1.1.4	1.301	4.80	28.08	Na ₂ SO ₄
1.408	24.07	11.76	" + CoSO ₄ ·H ₂ O	1.237	0.0	30.50	"
1.375	21.28	13.31	1.1.4				

1.1.4 = CoSO₄:Na₂SO₄·4H₂O

RESULTS AT SEVERAL OTHER TEMPERATURES
[(0°-40°) Koppel, Wetzel, 1905; (60°-100°) Benrath, 1931.]

t°	Gms. per 100 gms. sat. sol.		Solid Phase	t°	Gms. per 100 gms. sat. sol.		Solid Phase
	CoSO ₄	Na ₂ SO ₄			CoSO ₄	Na ₂ SO ₄	
0	16.56	7.63	Co7 + Na10	20	15.41	18.12	Na10
5	17.46	9.59	Na10	25	10.63	23.26	"
10	17.90	11.73	"	30	6.01	28.67	"
20	17.59	16.43	1:1.4	35	4.56	32.14	1:1.4 + Na ₂ SO ₄
25	17.06	15.70	"	40	4.72	31.78	Na ₂ SO ₄
30	15.94	14.93	"	60	33.85	4.11	Co6 + 1.1.4
35	15.73	14.52	"	60	29.71	7.27	1.1.4
40	14.87	14.22	"	60	11.57	19.98	"
18.5	18.75	15.61	1:1.4 + Co7	60	5.27	27.82	" + Na ₂ SO ₄
20	19.30	15.10	Co7	65	35.00	4.52	" + Co1
25	20.30	13.60	"	75	34.4	2.9	Co1
30	21.67	12.05	"	75	32.95	6.60	" + 1.1.4
35	22.76	10.43	"	75	14.12	17.58	1.1.4
40	24.05	9.16	"	75	6.90	28.75	" + Na ₂ SO ₄
18.5	16.87	16.97	1:1.4 + Na10	100	20.15	15.15	" + Co1

Co1 = CoSO₄·H₂O

Co6 = CoSO₄·6H₂O

Co7 = CoSO₄·7H₂O

Na10 = Na₂SO₄·10H₂O

1:1.4 = CoSO₄·Na₂SO₄·4H₂O

Co COBALT

EQUILIBRIUM IN THE SYSTEM COBALT SULFATE, NICKEL SULFATE AND WATER (Benrath and Thiemann, 1934)

Very painstaking determinations by Rohmer (14 isotherms between 0° and 61°, with crystallographic identification of the solid phases) generally confirm the results of Benrath and Thiemann. The same solid phases were found, and the two points located at which the solution is simultaneously saturated with three solid phases. The observed temperatures of these points were, however, 23.4° and 33.4°, instead of 21° and 26° reported by Benrath and Thiemann. There were also other points rectified or clarified by the experiments of Rohmer.

\$0	Mol. per cent CoSO ₄ in sat. sol.	Gm. mols. H ₂ O to dissolve 1 gm. sol. CoSO ₄ + NiSO ₄	Solid Phase		Mol. per cent CoSO ₄ in sat. sol.	Gm. mols. H ₂ O to dissolve 1 gm. sol. CoSO ₄ + NiSO ₄	Solid Phase
Results at 0°				Results at 50°			
100.	33.8	Co7		100.	16.53	Co6	
55.8	27.1	"		94.3	16.22	(NiCo)6	
53.5	26.8	" + N17		80.2	16.12	"	
51.3	27.2	N17		55.5	16.31	"	
45.9	27.8	"		43.3	16.14	"	
36.3	28.5	"		33.7	16.19	"	
0.0	30.8	"		20.15	16.16	"	
				12.90	16.30	"	
				4.24	16.34	"	
				2.31	16.46	"	
				0.0	16.56	Ni6α	
Results at 17.5°				Results at 70°			
100.	25.0	Co7		100.	13.93	Co6	
93.7	24.9	"		80.2	13.79	(NiCo)6	
73.3	23.4	"		50.3	14.00	"	
50.0	21.4	"		32.9	14.03	"	
46.7	21.1	" + N17		12.55	14.15	"	
45.9	27.8	N17		3.33	14.15	"	
30.8	22.1	"		0.0	14.33	Ni6β	
12.4	23.1	"					
0.0	23.5	"					
Results at 30°				Results at 90°			
100.	20.4	Co7		100.	18.96	Co1	
78.0	20.1	"		71.5	15.13	(NiCo)1	
69.1	18.77	" + (NiCo)6		51.8	13.58	"	
63.4	18.56	(NiCo)6		39.5	11.61	"	
55.0	18.6	"		39.2	11.50	(NiCo)6	
40.0	18.66	"		27.0	11.93	"	
29.9	18.8	Ni6α		9.73	12.09	"	
17.62	19.19	"		0.0	12.12	Ni6β	
9.40	19.5	"					
0.0	19.75	N17					

Results are also given for the temperatures, 26°, 33.5°, 41.5°, 79.3° and 98.5°.

Co7 = CoSO₄·7H₂O; Co6 = CoSO₄·6H₂O; N17 = NiSO₄·7H₂O; Ni6α = NiSO₄·6H₂Oα; (NiCo)6 = Mixed crystals of CoSO₄·6H₂O + NiSO₄·6H₂Oβ; (NiCo)1 = Mixed crystals of CoSO₄·H₂O + NiSO₄·H₂O; Ni6β = NiSO₄·6H₂Oβ.

(Cont.)

From the polytherm constructed from the numerical results, the following limiting points of the system were obtained:

t°	Mol. per cent CoSO ₄ in sat. sol.	Gm. mols. H ₂ O to dissolve 1 gm. sol. CoSO ₄ + Ni ₂ SO ₄	Solid Phase	
0	53.6	26.9	Co7 + Ni7	
41.5	100.0	17.55	Co7 + Co6	
31.5	0	19.4	Ni7 + Ni6α	
52.5	0	16.3	Ni6 + Ni6β	
71.0	100	13.8	Co6 + Col	
103 (?)	0	10.6	Ni6 + Ni1	
21	46.5	19.5	Co7 + Ni7 + (CoNi)6β	SO
26	35.0	19.5	Ni7 + Ni6α + (CoNi)6β	

THE SYSTEM COBALT SULFATE - RUBIDIUM SULFATE - WATER
(Benrath, 1932)

t°	Gms. per 100 gms. H ₂ O		Solid Phase	t°	Gms. per 100 gms. H ₂ O		Solid Phase
	CoSO ₄	Rb ₂ SO ₄			CoSO ₄	Rb ₂ SO ₄	
0	1.89	3.25	1.1.6	69	1.33	40.97	1.1.6 + Rb ₂ SO ₄
0	19.85	1.2	" + Co7	69	9.73	16.8	1.1.6
25	0.26	33.54	" + Rb ₂ SO ₄	69	37.2	5.6	" + Co6 + Col
25	3.96	6.81	1.1.6	88	12.96	22.35	1.1.6
25	27.63	2.47	" + Co7	88	28.46	13.79	" + Col
40	36.65	3.0	" + " + Co6	100	4.21	47.17	" + Rb ₂ SO ₄
44.5	6.38	11.04	1.1.6	100	14.88	25.57	1.1.6
60	8.45	14.6	"	100	25.35	19.10	" + Col

1.1.6 = CoSO₄·Rb₂SO₄·6H₂O; Co7 = CoSO₄·7H₂O; Co6 = CoSO₄·6H₂O;
Col = CoSO₄·H₂O.

SOLUBILITY OF COBALT RUBIDIUM SULFATE IN WATER
(Benrath, 1932)

[Solid phase CoSO₄·RbSO₄·6H₂O]

t°	Gms. CoRb ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. CoRb ₂ (SO ₄) ₂ per 100 gms. H ₂ O	t°	Gms. CoRb ₂ (SO ₄) ₂ per 100 gms. H ₂ O
0	5.1	40	18.7	80	45.0
10	7.5	50	24.2	90	55.0
20	10.8	60	30.3	100	70.0
30	14.5	70	37.1		

Co COBALT

THE SYSTEM COBALT SULFATE - THALLIUM SULFATE - WATER
(Benrath and Thiemann, 1932)

t°	Gms. per 100 gms. H ₂ O		Solid Phase	t°	Gms. per 100 gms. H ₂ O		Solid Phase
	CoSO ₄	Tl ₂ SO ₄			CoSO ₄	Tl ₂ SO ₄	
0	1.45	3.20	1.1.6 + Tl ₂ SO ₄	78.5	32.62	14.67	1.1.6 + Col
"	20.40	2.40	" + Co7	84.5	19.27	21.91	" + Tl ₂ SO ₄
25	0.85	5.42	Tl ₂ SO ₄	"	29.8	18.15	" + Col
"	3.17	6.0	" + 1.1.6	100	2.78	17.47	Tl ₂ SO ₄
"	3.64	5.58	1.1.6	"	7.83	20.22	"
30	5.64	4.75	"	"	17.94	25.94	"
"	23.54	3.14	"	"	21.16	26.89	"
"	26.6	2.96	" + Co7	"	23.69	28.47	" + Col
"	26.7	2.18	Co7	"	26.97	13.48	Col
36	4.27	7.37	1.1.6 + Tl ₂ SO ₄	39.5	31.7	4.64	Co7 + Co6 + 1.1.6
"	28.79	3.67	" + Co7	69.5	37.3	7.48	Col + " + "
50	7.37	11.3	" + Tl ₂ SO ₄	94	24.4	25.9	" + Tl ₂ SO ₄ + "
"	32.53	5.04	" + Co6				

Co7 = CoSO₄·7H₂O; Co6 = CoSO₄·6H₂O; Col = CoSO₄·H₂O;
1.1.6 = CoSO₄·Tl₂SO₄·6H₂O.

Data for the distribution of CoSO₄ between butyl alcohol and water with added H₂SO₄, Na₂SO₄ and (NH₄)₂SO₄ are given by Schlea, 1955.

SOLUBILITY OF ANHYDROUS COBALT SULFATE IN ABSOLUTE
METHYL AND ETHYL ALCOHOLS
(Gibson, Driscoll and Jones, 1929)

Results for Methyl Alcohol			Results for Ethyl Alcohol		
t°	Gms. CoSO ₄ per 100 gms. CH ₃ OH	Phase	t°	Gms. CoSO ₄ per 100 gms. C ₂ H ₅ OH	Solid Phase
15	0.300	CoSO ₄	15	0.017	CoSO ₄
25	0.418	"	25	0.018	"
35	0.419	"	45	0.023	"
45	0.372	"	55	0.026	"
55	0.267	"			

"100 gms. of a saturated solution in glycol contain 3.1 gms. CoSO₄·7H₂O". (de Coninck, 1905)

Melting point data are given for:

CoSO₄ + KCl, KBr, RbCl (binary systems) (Bergman and Golubeva, 1953)
CoSO₄ + 2KCl \rightleftharpoons CoCl₂ + K₂SO₄ (Golubeva and Bergman, 1953)
CoSO₄ + Li₂SO₄, K₂SO₄, Na₂SO₄ (binary) (Calcagni and Marotta, 1913)

COBALT SELENATE CoSeO_4

SeO

SOLUBILITY OF COBALT SELENATE IN WATER
(Klein, 1940)

t°	Density	Gms. CoSeO_4 per 100 gms. Sat. Sol.	Gas. CoSeO_4 per 100 gms. H_2O	Solid Phase
-1.7	1.1705	15.40	18.20	Ice
-3.5	1.2764	23.47	30.66	"
-6.4	-	30.25	43.37	Ice + $\text{CoSeO}_4 \cdot 7\text{H}_2\text{O}$
0	1.4255	31.95	46.95	$\text{CoSeO}_4 \cdot 7\text{H}_2\text{O}$
10	1.4690	34.69	53.11	"
15	1.4786	35.48	54.99	$\text{CoSeO}_4 \cdot 6\text{H}_2\text{O}$
21.6	1.4911	36.12	56.54	"
26	1.4958	36.39	57.20	"
30	1.5050	36.80	58.60	"
*52.2	1.5411	39.72	65.89	"
*70	1.5722	41.48	70.88	"
*30	1.5100	37.42	59.79	$\text{CoSeO}_4 \cdot 4\text{H}_2\text{O}$
40	1.5104	37.54	60.10	"
50	1.5113	37.72	60.56	"
*60	1.5118	37.97	61.05	"
*80	1.3978	32.73	48.66	$\text{CoSeO}_4 \cdot \text{H}_2\text{O}$
84.5	1.3250	28.37	39.61	"
90	1.2505	23.94	31.47	"
95	1.1992	20.44	27.79	"
100	1.1622	17.98	21.92	"

*Indicates Metastable

CASSIOPEIUM (see LUTETIUM)

CHROMIUM Cr

Cr

The approximate percentage solubility of Chromium in Mercury is less than 5×10^{-5} . (Irvin and Rusacl, 1932)

CHROMIUM ACETATE $\text{Cr}(\text{CH}_3\text{COO})_3 \cdot \text{H}_2\text{O}$

CH

SOLUBILITY OF ANHYDROUS CHROMIUM ACETATE IN METHYL ALCOHOL AND IN ACETONE
(Henstock, 1934)

Solvent	t°	Gms. $\text{Cr}(\text{CH}_3\text{COO})_3$ per 100 gms. of solvent
Methyl Alcohol CH_3OH	15°	4.76
" " "	66.9 (b.pt.)	8.66
" Acetone CH_3COCH_3	15	0.20

Cr CHROMIUM

CH CHROMIUM HELIANTHATE $\text{Cr}(\text{C}_{14}\text{H}_{14}\text{H}_3\text{SO}_3)_3 \cdot 6\text{H}_2\text{O}$

1000 cc H_2O dissolve 0.176 gms. of the hydrated salt (= 0.15 gm. helianthine) at 20-25°. (Stark and Dehn, 1918)

 (NH_3) CHROMIUM AMMINES

SOLUBILITY OF CHROMIUM HEXAMMINE SALTS IN WATER AT 17.5°
(Ephraim and Mosimann, 1922)

On account of the rapidity of decomposition of the salts, the saturated solutions were prepared by shaking for a period of not more than two hours.

Salt	Formula	Per 1000 cc sat. sol.	
		Gms. Cr	Gm. mols. salt
Chromi-Hexamine Chloride	$[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$	21.9	0.42
" Bromide	$[\text{Cr}(\text{NH}_3)_6]\text{Br}_3$	6.12	0.118
" Iodide	$[\text{Cr}(\text{NH}_3)_6]\text{I}_3$	2.25	0.043
" Nitrate	$[\text{Cr}(\text{NH}_3)_6][\text{NO}_3]_3$	3.74	0.072
" Dichromate	$[\text{Cr}(\text{NH}_3)_6][\text{Cr}_2\text{O}_7]_3$	0.26	0.005
" Sulfate	$[\text{Cr}(\text{NH}_3)_6]_2[\text{SO}_4]_3$	2.43	0.046
" Phosphate	$[\text{Cr}(\text{NH}_3)_6]_2[\text{PO}_4]_3$	0.1676	0.0032
" Oxalate	$[\text{Cr}(\text{NH}_3)_6]_2[\text{C}_2\text{O}_4]_3$	0.1876	0.00084
" Picrate	$[\text{Cr}(\text{NH}_3)_6][\text{O}-\text{C}_6\text{H}_2(\text{NO}_2)_3]_3$	0.0190	0.00037
" { Naphthalene } { β Sulfonate }	$[\text{Cr}(\text{NH}_3)_6][\text{C}_{10}\text{H}_7\text{SO}_3]_3$	0.0352	0.00069
" Chlorate	$[\text{Cr}(\text{NH}_3)_6][\text{ClO}_3]_3$	3.25	0.062
" Perchlorate	$[\text{Cr}(\text{NH}_3)_6][\text{ClO}_4]_3$	1.03	0.0199
" Perrhenate	$[\text{Cr}(\text{NH}_3)_6](\text{ReO}_4)_3 \cdot 2\text{H}_2\text{O}$	-	0.00073(1)(20°)
" Permanganate	$[\text{Cr}(\text{NH}_3)_6](\text{MnO}_4)_3$	-	0.0035 (2)
" Boro fluoride	$[\text{Cr}(\text{NH}_3)_6](\text{BF}_4)_3$	-	0.0412 (2)

(1) Wilke-Dörfurt and Gundzert, 1933 (2) Weinhardt, 1926.

SOLUBILITY OF CHROMIUM PENTAMMINE SALTS IN WATER

Formula	t°	Moles salt per liter sat. sol.	Author
$[\text{Cr}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$	0	0.0149	(Brönsted and Petersen, 1921)
	16	0.0261	(*)
	20	0.017	(Yatmirskii, 1950)
		0.030	(Brönsted and Petersen, 1921)
{ " } Br_2	20	0.0161	(Yatmirskii, 1950)
{ " } $(\text{NO}_3)_2$	17.5	0.047	(*)
	20	0.043	(Yatmirskii, 1950)
		0.053	(Brönsted and Petersen, 1921)
$[\text{Cr}(\text{NH}_3)_5]_2[\text{C}_2\text{O}_4]$	0	0.00125	(Brönsted and Petersen, 1921)
$[\text{Cr}(\text{NH}_3)_5\text{SCN}]\text{Cl}_2$	20	0.040	(" " " ")
$[\text{Cr}(\text{NH}_3)_5\text{H}_2\text{O}](\text{ClO}_4)_3$	20	0.240	(Linhard and Berthold, 1955)
$[\text{Cr}(\text{NH}_3)_5\text{N}_3](\text{ClO}_4)_2$	20	0.114	(" " " ")
{ " } $(\text{NO}_3)_2$	20	0.0252	(" " " ")
{ " } Cl_2	20	0.0924	(" " " ")
{ " } Br_2	20	0.0221	(" " " ")
{ " } I_2	20	0.0157	(" " " ")

* = Jörgensen, 1879, 1884, 1890; Struve, 1899.

SOLUBILITY OF CHROMIUM TETRAMINES IN WATER

Formula	t°	Solubility	Author
$[\text{Cr}(\text{NH}_3)_4\text{Cl}(\text{H}_2\text{O})]\text{Cl}_2$	15°	6.3 gms. per 100 gms. H_2O	(Jørgensen, 1879, 1884, 1890; Struve, 1899)

CHROMIUM DIAMINES

Data for the distribution of compounds of the type $\text{M}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$ (reineckates) where M = Cs, Na, K, NH_4 between nitromethane and water are given by Friedman and Haugen, 1954.

CHROMIUM HEXAUREA COMPOUNDS

SOLUBILITY OF EACH SEPARATELY IN WATER AT 20°
(Wilke-Dorfurt and Niederer, 1929)

Compound	Formula	Gm. Mols. Compound per liter sat. sol.
Chromium Hexa Urea:		
Chloride	$[\text{Cr}(\text{CO}(\text{NH}_2)_2)_6]\text{Cl}_3 \cdot 3\text{H}_2\text{O}$	0.20
Bromide	" $\text{Br}_3 \cdot 3\text{H}_2\text{O}$	0.20
Iodide	" I_3	0.075
Nitrite	" $(\text{NO}_2)_3$	0.16
Nitrate	" $(\text{NO}_3)_3$	0.10
Perchlorate	" $(\text{ClO}_4)_3$	0.006
Chloride Sulfate	" ClSO_4	0.048
Boro fluoride	" $(\text{BF}_4)_3$	0.005
Chlorate	" $(\text{ClO}_3)_3$	0.15
Thiosulfate	" $2(\text{S}_2\text{O}_3)_3 \cdot 3\text{H}_2\text{O}$	0.006
Bichromate	" $2(\text{Cr}_2\text{O}_7)_3$	0.0015
Fluosilicate	" $2(\text{SiF}_6)_3 \cdot 6\text{H}_2\text{O}$	0.004
Cobalti cyanide	" $\text{Co}(\text{CN})_6 \cdot 4\text{H}_2\text{O}$	0.0008
Sulfate perchlorate	" $\text{SO}_4\text{ClO}_4 \cdot \text{H}_2\text{O}$	0.01
" fluoborate	" $\text{SO}_4\text{BF}_4 \cdot \text{H}_2\text{O}$	0.01
" fluosulfonate	" $\text{SO}_4\text{SO}_3\text{F} \cdot 3\text{H}_2\text{O}$	0.01
" iodide	" $\text{SO}_4\text{I} \cdot 2\text{H}_2\text{O}$	0.015
" bromide	" $\text{SO}_4\text{Br} \cdot 2\text{H}_2\text{O}$	0.03
" nitrate	" $\text{SO}_4\text{NO}_3 \cdot \text{H}_2\text{O}$	0.01
" chlorate	" $\text{SO}_4\text{ClO}_3 \cdot 3\text{H}_2\text{O}$	0.01
Bichromate bromide	" $\text{Cr}_2\text{O}_7\text{Br} \cdot \text{H}_2\text{O}$	0.006
" nitrate	" $\text{Cr}_2\text{O}_7 \cdot \text{NO}_3$	0.01
" perchlorate	" $\text{Cr}_2\text{O}_7 \cdot \text{ClO}_4$	0.007
" borofluoride	" $2\text{Cr}_2\text{O}_7(\text{BF}_4)_4$	0.003
" di sulfate	" $2\text{Cr}_2\text{O}_7(\text{SO}_4)_2 \cdot 5\text{H}_2\text{O}$	0.0025
Nickel cyanide chloride	" $\text{Ni}(\text{CN})_4 \text{Cl} \cdot 2\text{H}_2\text{O}$	0.08
Perrhenate (1)	" $(\text{ReO}_4)_3$	0.0154 (1)
Permanganate	" $(\text{MnO}_4)_3$	0.084 (2)
Fluosulfonate	" $(\text{SO}_3\text{F})_3$	0.063 (2)
Nitro Toluene sulfonate	" $(\text{C}_7\text{H}_6(\text{NO}_2)\text{SO}_3)_3$	0.033 (3)

(1) Wilke-Dorfurt and Gundzert, 1933. The solubility of Cr hexa urea perrhenate in alcohol at 20° is 0.0057 gm. mol. per liter. (2) Weinhardt, 1926. (3) Yatmirekii, Prik, Skvirskaya and Starostin, 1951.

Cr CHROMIUM

CHROMIUM HEXA ANTIPYRINE COMPOUNDS

SOLUBILITY OF EACH SEPARATELY IN WATER AT 20°
(Wilke-Dörfurt and Mureck, 1929)

Compound	Formula	Gms. Compound per 100 cc sat. sol.
Chromium Hexa Antipyrine:		
Chlorate	$\left[\text{Cr}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6 \right] (\text{ClO}_3)_3$	4.3
Boro fluoride	$\left[\text{ " } \right] (\text{BF}_4)_3$	0.043
Bi chromate	$\left[\text{ " } \right] (\text{Cr}_2\text{O}_7)_3$	0.06
Thiocyanate	$\left[\text{ " } \right] (\text{SCN})_3$	3.1
Ferricyanide	$\left[\text{ " } \right] [\text{Fe}(\text{CN})_6]$	0.07
Picrate	$\left[\text{ " } \right] [\text{O}(\text{NO}_2)_2\text{C}_6\text{H}_2]_3$	0.0015
Perchlorate	$\left[\text{ " } \right] [\text{ClO}_4]_3$	0.065*

*Wilke-Dörfurt and Schliephake, 1929.

CHROMIUM ETHYLENE DIAMINE-AZIDE COMPOUNDS

SOLUBILITY IN WATER AT 20°
(Linhard and Weigel, 1953)

	Moles salt per liter	Gms. salt per liter
cis- $\left[\text{Cr}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2(\text{N}_3)_2 \right] \text{I}$	0.0155	5.92
" $\left[\text{ " } \right] \text{ClO}_4$	.0216	7.67
" $\left[\text{ " } \right] \text{NO}_3$	.0277	8.82
" $\left[\text{ " } \right] \text{Br}$	.0380	12.8
" $\left[\text{ " } \right] \text{N}_3$	.0547	16.3

COBALT HEXATHIOCYANATE - PYRAMIDONES

SOLUBILITY IN WATER AT 15°
(Gulyaeva, 1950)

[P = Pyramidone]

Salt	Gms. per 100 ml. H ₂ O
$\left[\text{Cr}(\text{CNS})_6 \right] \text{H}_3\text{P}_3$	0.07
$\left[\text{ " } \right] \text{CrP}_3$	.08
$\left[\text{ " } \right] \text{ALP}_3$	.07
$\left[\text{ " } \right] \text{FeP}_3$	.018

CHROMIUM THIOCYANATE $\text{Cr}(\text{SCN})_3$

CNS

Data for the distribution of $\text{Cr}(\text{SCN})_3$ between water and ether at 0°-30° are given by Hantzsch and Vagt, 1901. See also Bjorrum, 1921, 1921a and Bock, 1951.

CHROMIUM CHLORIDES $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$

Cl

SOLUBILITY OF THE GREEN AND THE VIOLET MODIFICATIONS IN WATER AT 25°
(Olie Jr., 1906)

The solubility of hydrated chromium chloride depends upon the inner composition of the solution, that is, the relative amounts of the green and the violet modification of the salt present in the saturated solution. These are determined by precipitating with silver nitrate. A freshly prepared solution of the green chloride yields only one-third of its chlorine in the cold, hence the composition of this modification, according to Werner, is represented by the formula $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$. The violet chloride is considered to have the composition, $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$. A determination of the amount of each present involves precipitating one portion of the solution at 0° with silver nitrate and another portion (for total Cl) at the boiling point. Experiments were first made with aqueous solutions of different percentage composition of the two modifications. These were agitated at 25° and analyzed at intervals until equilibrium was reached. The time for equilibrium varied from 18 to 40 days according to the concentrations present. The effect of temperature and of the presence of HCl on the transition of the green chloride was also studied. In a later paper Olie Jr. (1907) gives additional results at 29°, 32° and 35°.

The equilibrium in saturated solutions at 25° was determined by rubbing the hydrated chromium chloride with a little water previously cooled to 0° to a thin mush. This was then agitated at 25° and portions removed at successive intervals of time and analyzed. The results show the total chloride and per cent present as the green modification.

25 Gms. Green Salt + 10 Gms. H_2O			25 Gms. Violet Salt + 10 Gms. H_2O		
Time of Agitation	Gms. CrCl_3 per 100 Gms. Sat. Sol.	Per cent of Green Salt	Time of Agitation	Gms. CrCl_3 per 100 gms. Sat. Sol.	Per cent of Green Salt
$\frac{1}{2}$ hour	58.36	91.7	$\frac{1}{2}$ hour	61.99	1.53
4 hours	63.27	75.2	1 day	63.88	8.46
1 day	68.50	62.36	4 days	70.68	30.89
3 days	68.95	57.22	7 days	72.11	37.28
19 days	68.58	57.38	26 days	70.62	51.54

25 Gms. Violet Salt + 10 cc of 35% Sol. of the Green Salt		
Time of Agitation	Gms. CrCl_3 per 100 Gms. Sat. Sol.	Per cent of Green Salt
$\frac{1}{2}$ hour	65.49	15.95
2 days	70.47	26.81
5 days	76.38	39.34
8 days	73.26	34.20
12 days	71.14	58.60

Cr CHROMIUM

100 cc anhydr. hydrazine dissolve 13 gms. CrCl_3 at room temp. (Welsh and Broderson, '15)

Data for the change in the critical solution temperature of systems composed of water and butyric acid, water and isobutyric acid etc., caused by the addition of various amounts of violet chromium chloride and green chromium chloride, are given by Howard and Patterson, 1926.

A mixture of equal volumes of diethyl ether and water at 0° when saturated with HCl will dissolve 0.03 gms. Green CrCl_3 or 0.0057 gms. Violet CrCl_3 in 100 cc of the mixture. Fischer and Seidel (1941).

The extraction of CrCl_3 (green) by ether from aqueous solutions containing NH_4SCN and HCl has been studied by Book, 1951.

CrO CHROMIUM PERCHLORATE $\text{Cr}(\text{ClO}_4)_3$

SOLUBILITY OF CHROMIUM PERCHLORATE IN WATER (Bibere and Neumann, 1937)

t°	$\frac{d\%}{dt}$ of sat. sol.	Gms. $\text{Cr}(\text{ClO}_4)_3$ per 100 gms. sat. sol.	Solid Phase
0	-	50.99	$\text{Cr}(\text{ClO}_4)_3 \cdot 9\text{H}_2\text{O}$
5	-	52.88	"
10	-	55.10	"
15	1.6463	55.31	"
25	-	57.73	"

F CHROMIUM FLUORIDE CrF_3

THE SYSTEM CrF_3 - NaF - H_2O AT 30° (Talipov and Antipov, 1952)

Solutions of CrF_3 and NaF were kept in paraffin coated flasks for 1-1½ months with 6-8 hours shaking daily.

Liquid phase Wt. %		Solid phase Wt. %		Solid
NaF	CrF_3	NaF	CrF_3	
3.884	-	40.56	34.42	$3\text{NaF} \cdot \text{CrF}_3$
2.795	-	40.58	35.90	"
2.420	-	27.53	24.42	"
2.321	-	40.56	36.04	"
2.001	0.001	39.77	36.74	" + $2\text{NaF} \cdot \text{CrF}_3$
1.098	0.004	41.48	43.44	" + "
0.684	0.4361	41.12	45.26	" + "

THE SYSTEM $\text{CrF}_3 - \text{KF} - \text{H}_2\text{O}$ AT 25°
(Talipov and Fedorova, 1954)

F

[$2\text{KF} \cdot \text{CrF}_3$ is congruently soluble]

Gms. per 100 gms. sat. sol.

<div style="display: flex; justify-content: space-around;"> KF CrF_3 </div>		Solid Phase
< 0.12	-	$\text{CrF}_3 \cdot 3\text{H}_2\text{O}$
0.5	1.84	$\text{CrF}_3 \cdot 3\text{H}_2\text{O} + 2\text{KF} \cdot \text{CrF}_3 \cdot \text{H}_2\text{O}$
> 0.5	(to saturation)	$2\text{KF} \cdot \text{CrF}_3 \cdot \text{H}_2\text{O}$

CHROMYL FLUORIDE CrO_2F_2

OF

THE SYSTEM $\text{HF} - \text{CrO}_3 - \text{H}_2\text{O}$ AT 0°
(Nikolaev and Buslaev, 1955)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HF	CrO_3		HF	CrO_3		HF	CrO_3	
7.02	51.7	CrO_3	52.0	4.2	CrO_3	90.1	6.05	CrO_2F_2
10.6	45.3	"	54.5	3.6	"	95.0	3.56	"
12.75	42.1	"	60.2	6.75	"	98.2	2.17	"
20.4	31.6	"	61.2	13.8	"	75.7	15.2	"
30.3	21.2	"	60.8	19.2	CrO_2F_2	70.5	19.0	"
42.1	10.8	"	81.7	9.1	"	55.7	38.7	CrO_3
50.8	5.4	"						

SOLUBILITY OF CHROMYL FLUORIDE IN HYDROGEN FLUORIDE
(Nikolaev and Buslaev, 1955)

t°	$-75 \pm 1^\circ$	$-40 \pm 2^\circ$	$+1.5 \pm 0.5^\circ$	$+16 \pm 1^\circ$
Wt. % CrO_2F_2 in Sat. Sol.	0.0274	0.289	3.02	11.07

CHROMIC NITRATE $\text{Cr}(\text{NO}_3)_3$

NO

SOLUBILITY IN WATER
(Serebrennikova, 1953; Smith, 1945)

t°	Gms. $\text{Cr}(\text{NO}_3)_3$ per 100 gms. sat. sol.	Solid Phase
5	39.21	$\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
15	42.45	"
25	43.62	"
	(44.83) (Smith)	"
35	47.50	"

Cr CHROMIUM

SOLUBILITY OF CHROMIC NITRATE IN NITRIC ACID SOLUTIONS
(Serebrennikova, 1953)Gms. per 100
gms. sat. sol.

	Cr(NO ₃) ₃	HNO ₃	Density	Solid Phase
			Results at 5°	
NO	39.21	0.0	1.433	Cr(NO ₃) ₃ ·9H ₂ O
	32.44	7.82	1.406	"
	23.78	17.96	1.381	"
	23.47	17.45	1.375	"
	19.30	22.87	1.365	"
	17.91	25.40	1.389	"
	13.20	28.16	1.352	"
	11.61	31.84	1.429	"
	3.92	46.13	1.350	"
	1.43	55.22	1.443	"
Results at 15°				
	42.45	1.38	1.435	Cr(NO ₃) ₃ ·9H ₂ O
	34.68	6.83	1.433	"
	27.43	14.03	1.403	"
	18.30	27.33	1.370	"
	10.32	39.49	1.363	"
	4.28	50.09	1.377	"
	3.60	52.14	1.375	"
	2.17	55.85	-	"
	2.63	58.05	-	Cr(NO ₃) ₃ ·9H ₂ O + Cr(NO ₃) ₃ ·3H ₂ O
	1.92	60.50	-	"
	2.57	65.29	-	"
	0.66	68.60	-	"
	0.45	80.25	-	"
Results at 25°				
	43.62	2.24	1.480	Cr(NO ₃) ₃ ·9H ₂ O
	39.97	6.92	1.442	"
	33.02	12.34	1.445	"
	24.49	23.69	1.417	"
	15.88	35.42	1.404	"
	8.88	45.95	1.400	"
Results at 35°				
	47.50	0.0	-	Cr(NO ₃) ₃ ·9H ₂ O
	47.17	3.90	-	"
	45.65	3.55	1.518	"
	42.27	6.95	1.467	"
	39.07	11.59	1.494	"
	34.74	16.65	1.483	"
	33.08	18.20	1.482	"
	21.42	34.50	1.454	"
	16.82	42.60	-	"
	17.63	46.63	-	Cr(NO ₃) ₃ ·9H ₂ O + Cr(NO ₃) ₃ ·3H ₂ O
	9.33	57.15	-	Cr(NO ₃) ₃ ·3H ₂ O ••
	5.11	64.31	-	"
	1.03	75.98	-	"
	2.81	80.20	-	Cr(NO ₃) ₃ ·3H ₂ O + Cr(NO ₃) ₃
	2.5	84.	-	Cr(NO ₃) ₃

CHROMOUS HYDROXIDE $\text{Cr}(\text{OH})_2$

OH

The pH of precipitation of $\text{Cr}(\text{OH})_2$ from very dilute solutions of CrSO_4 was found to be 5.6 and from this the solubility product of $\text{Cr}(\text{OH})_2$ calculated to be approximately 2.0×10^{-20} at 18. (Bennett, 1932)

Hume and Stone (1941) found that a basic salt precipitated from a solution of CrCl_2 at pH 5.8. Using a method similar to that of Bennett, and assuming the precipitate to be $\text{Cr}(\text{OH})_2$, the solubility product was found to be 5×10^{-19} . Upon addition of equivalent quantities of acid and base to precipitate $\text{Cr}(\text{OH})_2$, the observed K_{sp} was 1×10^{-17} , but the authors point out that although these values may be of practical importance, the existence of various basic salts in the precipitate makes an exact interpretation impossible.

CHROMIC HYDROXIDE $\text{Cr}(\text{OH})_3$

OH

Oka, 1940 found the solubility to be 1.2×10^{-8} moles per liter by potentiometric titration.

SOLUBILITY OF CHROMIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF
SODIUM HYDROXIDE AT ROOM TEMPERATURE
(Erich Müller, 1924; Fricke and Windhausen, 1924)

Müller gives data for the effect upon the equilibrium, of time, temperature, concentration of sodium hydroxide and amount of chromium hydroxide present. The results show that chromium hydroxide is a solid solution in which simple and polymeric molecules are present in homogeneous mixture.

The following results by Fricke and Windhausen give a curve, the ascending branch of which (up to concentrations of 10 normal NaOH) corresponds to the formation of monosodium chromite. Analyses of the solid phase for the descending curve corresponded to $\text{Cr}_2\text{O}_3 \cdot 3\text{Na}_2\text{O} \cdot 8\text{H}_2\text{O}$ + retained NaOH.

Three days were allowed for equilibrium. Experiments are also given for chromium hydroxide which had been altered by contact with concentrated KOH for increasing lengths of time.

Normality of NaOH	Gms. Cr_2O_3 per 100 cc Sat. Sol.	Normality of NaOH	Gms. Cr_2O_3 per 100 cc Sat. Sol.
0.9	0.25	10.20	2.48
1.71	0.5	11.06	1.90
3.65	1.10	12.01	1.51
5.10	1.68	13.26	1.09
7.25	2.09	14.15	0.80
8.56	2.52	15.60	0.40
9.89	2.89	17.42	*
10.00	2.63		

*Almost colorless solution.

Cr CHROMIUM

0 CHROMIUM TRIOXIDE CrO_3

SOLUBILITY IN WATER

(Büchner, and Prins, 1912-13; Kremann, Daimer and Bennesch, 1911; Koppel and Blumenthal, 1907; Mylius and Funk, 1900; Rakowsky and Tarascenkow; Mutual, 1950; Vuillard, 1951)

The hydrate $\text{CrO}_3 \cdot 3.5\text{H}_2\text{O}$ was found by Vuillard. Earlier investigators reported the eutectic to lie at -155° , 60.5% CrO_3 (CrO_3 + Ice as solids).

Gms. CrO ₃ per 100 Gms. Sat. Sol.			Solid Phase	Gms. CrO ₃ per 100 Gms. Sat. Sol.			Solid Phase
t°				t°			
- 0.9	3.6	Ice		+ 18	62.45	CrO ₃	
- 1.9	7.8	"		20	62.58	"	
- 3.7	11.5	"		24.8	62.88	"	
- 4.8	14.1	"		40	63.3	"	
- 10.95	24.9	"		50	64.55	"	
- 11.7	25.2	"		60	64.78	"	
- 18.75	33.5	"		65	64.83	"	
- 25.25	39.2	"		80	65.7	"	
- 43.5	49.1	"		82	66.0	"	
- 60	53.3	"		90	68.5	"	
-113	59.0	CrO ₃ · 3.5H ₂ O + Ice		100	67.4	"	
-102	60.0	" + CrO ₃		115	68.4	"	
- 20	61.7	CrO ₃		122	70.7	"	
0	62.24	"		193-196	100	decomposition	

SOLUBILITY OF CHROMIUM TRIOXIDE IN AQUEOUS SOLUTIONS OF NITRIC ACID (Mumford and Gilbert, 1923)

The solid phase was CrO_3 in all cases.

Results at 25°

Results at 45°

d_{40}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		d_{40}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.	
	HNO_3	CrO_3		HNO_3	CrO_3
1.704	0.0	62.85	1.695	0.0	63.51
1.684	2.28	60.31	1.676	2.05	61.27
1.661	5.95	56.57	1.654	5.58	57.93
1.640	9.37	52.51	1.619	11.47	51.71
1.606	13.25	48.10	1.569	19.53	43.41
1.570	19.30	41.97	1.490	33.29	29.57
1.528	26.79	34.32	1.409	50.69	13.15
1.481	35.35	25.54	1.384	65.74	2.47
1.434	46.91	14.63	1.416	73.81	0.88
1.402	59.11	4.88	1.450	81.55	0.44
1.409	68.49	0.95	1.481	88.35	0.60
1.440	74.47	0.27	1.512	91.83	3.39
1.456	82.90	0.06	1.581	88.06	9.42
1.466	86.56	0.10			
1.475	89.17	0.18			
1.503	92.63	1.89			
1.557	91.36	8.29			

THE SYSTEM CHROMIUM TRIOXIDE - SULFUR TRIOXIDE - WATER
Results of Rakowsky and Tarassenkow, 1928 at several temperatures

Gm. mols. per 100 gm. mols. sat. sol.		Solid Phase	Gm. mols. per 100 gm. mols. sat. sol.		Solid Phase
CrO ₃	SO ₃		CrO ₃	SO ₃	
Results at 0°			Results at 40°		
22.67	0.0	CrO ₃	23.57	0.0	CrO ₃
10.19	7.36	"	10.95	7.31	"
3.32	12.09	"	3.81	12.15	"
0.75	16.51	"	1.03	16.51	"
0.10	23.22	"	0.12	22.84	"
0.22	27.30	"	0.23	26.94	"
0.65	29.61	"	1.48	31.83	"
2.46	32.43	"	3.58	34.01	"
3.28	33.18	"	4.21	34.93	"
10.93	35.22	"	6.14	36.52	"
1.23	30.97	CrO ₃ ·SO ₃	1.66	32.15	CrO ₃ ·SO ₃
0.82	31.40	"	1.33	33.14	"
0.58	33.18	"	1.02	34.25	"
0.33	35.52	"	0.62	36.81	"
0.17	40.48	"	0.32	42.28	"
0.09	44.40	"	0.29	42.83	"
Results at 20°			Results at 75°		
23.15	0.0	CrO ₃			
20.57	1.87	"			
18.93	2.68	"	2.22	33.66	CrO ₃ ·SO ₃
15.72	4.41	"	1.46	37.02	"
12.73	6.00	"	0.92	40.97	"
10.55	7.38	"	0.30	49.89	"
8.08	8.95	"			
5.40	10.53	"			
3.59	12.19	"			
1.90	14.44	"			
0.87	16.77	"	26.38	0.0	CrO ₃
0.43	18.56	"	13.38	7.13	"
0.22	19.88	"	6.98	11.20	"
0.10	23.64	"	0.64	20.08	"
0.14	25.73	"	0.31	24.01	"
0.41	28.92	"	1.67	31.86	"
1.83	32.57	"	2.47	32.59	"
4.48	34.91	"	3.45	33.79	"
8.48	37.89	"	4.97	35.13	"
1.44	31.73	CrO ₃ ·SO ₃	2.74	36.44	CrO ₃ ·SO ₃
1.33	32.05	"	2.30	36.83	"
0.69	34.07	"	1.57	39.30	"
0.37	37.36	"	1.30	41.90	"
0.29	38.97	"			
0.11	46.44	"			

(Cont.)

Cr CHROMIUM

Results of Gilbert, Buckley and Masson, 1922 at 25° and 45°

The mixtures were rotated in sealed tubes in a thermostat. Equilibrium was approached from above and from below. The solid phases were determined by direct analysis and by the "rest method".

Results at 25°

	$\frac{d_{25}}{4}$ of sat. sol.	Mol. per cent		Solid Phase	$\frac{d_{25}}{4}$ of sat. sol.	Mol. per cent		Solid Phase
		SO ₃	CrO ₃			SO ₃	CrO ₃	
	-	0.0	25.73	CrO ₃	1.786	32.64	1.62	CrO ₃
0	1.669	1.55	20.69	"	1.788	33.17	1.58	CrO ₃ ·SO ₃
	1.626	3.34	17.41	"	1.803	33.14	1.02	"
	1.579	5.73	13.20	"	1.806	34.29	0.97	"
	1.520	7.51	9.70	"	1.799	35.41	0.80	"
	1.496	9.99	6.13	"	1.801	36.14	0.54	"
	1.460	12.61	3.38	"	1.818	38.11	0.71	"
	1.479	15.89	1.17	"	1.837	38.81	1.12	"
	1.580	22.15	0.14	"	1.814	37.79	0.43	"
	1.610	23.22	0.11	"	1.812	38.69	0.50	"
	1.680	26.43	0.23	"	1.823	38.97	0.36	"
	1.690	27.56	0.28	"	-	45.80	0.44	CrO ₃ ·SO ₃ ·H ₂ O*
	1.690	28.17	0.28	"	1.834	47.01	0.20	"
	1.723	29.35	0.55	"	1.841	51.78	0.14	"
	1.756	31.42	0.97	"	1.915	57.50	0.40	"
	1.771	31.93	1.23	"	-	58.94	0.88	"

Results at 45°

	$\frac{d_{45}}{4}$ of sat. sol.	Mol. per cent		Solid Phase	$\frac{d_{45}}{4}$ of sat. sol.	Mol. per cent		Solid Phase
		SO ₃	CrO ₃			SO ₃	CrO ₃	
	-	5.25	13.79	CrO ₃	-	35.40	1.06	CrO·SO ₃
	-	16.73	1.00	"	-	37.07	0.63	"
	-	22.01	0.17	"	1.797	38.10	0.60	"
	1.751	31.05	1.16	"	1.814	42.26	0.38	"
	-	33.55	1.15	CrO·SO ₃	-	45.67	0.30	CrO·SO ₃ ·H ₂ O*

*The composition of this solid phase was not determined with certainty.

SOLUBILITY OF CHROMIUM TRIOXIDE IN SULFURIC ACID SOLUTIONS

Results of Meyer and Stateczny, 1922 at 23°

Per cent H ₂ SO ₄	$\frac{d_{23}}{23}$ of H ₂ SO ₄	$\frac{d_{23}}{23}$ of sat. sol. of CrO ₃ in H ₂ SO ₄	Concentration*	Per cent CrO ₃
20.4	1.139	1.510	49.19	29.25
39.6	1.296	1.511	21.55	14.23
60.7	1.501	1.516	1.53	1.01
75.8	1.672	1.680	0.82	0.49
79.6	1.717	1.730	1.37	0.79

*No explanation is given by the authors of the terms implied by this heading.

(Cont.)

SOLUBILITY OF CHROMIUM TRIOXIDE IN SULFURIC ACID--Contd.

Per cent H ₂ SO ₄	d_{23} of H ₂ SO ₄	d_{23} of sat. sol. of CrO ₃ in H ₂ SO ₄	Concentration*	Per cent CrO ₃
84.9	1.772	1.788	1.65	0.92
85.1	1.774	1.796	2.22	1.24
90.3	1.814	1.832	1.88	1.03
92.5	1.820	1.822	0.20	0.11
97.2	1.832	1.840	0.84	0.46
97.6	1.833	1.840	0.78	0.42
99.9	1.831	1.835	0.43	0.23
99.95	1.830	1.833	0.30	0.16
100.00	1.829	1.831	0.15	0.076

0

*No explanation is given by the authors of the terms implied by this heading.

Data for the freezing-points of mixtures of CrO₃ and H₂SO₄ are given by Meyer and Stateczny, 1922.

Data for the solubility of CrO₃ in solutions containing H₂SO₄, Fe, Mg, Al, and Cr are given by Wylie, et al (1950).

SOLUBILITY OF CHROMIUM TRIOXIDE IN SELENIC ACID AT 23°
(Meyer and Stateczny, 1922)

Per cent H ₂ SeO ₄	d_{23} of H ₂ SeO ₄	d_{23} of sat. sol. of CrO ₃ in H ₂ SeO ₄	Concentration*	Per cent CrO ₃
55.1	1.581	1.730	14.95	8.65
81.2	2.142	2.145	0.35	0.16
87.9	2.325	2.330	0.67	0.29
96.2	2.525	2.253	0.43	0.17
98.5	2.590	2.599	0.90	0.35

*No explanation is given by the authors of the terms implied by this heading.

Data for the solubility of chromium trioxide in HF solutions are given on page 865.

SOLUBILITY OF CrO₃ IN ACETIC ACID AND CHROMIC ACETATE SOLUTIONS
AT ROOM TEMPERATURE
(Roczek, 1955, 1955a)

Time of Shaking (min.)	Wt. % CrO ₃					
	0.03M HOAc	0.08M HOAc	0.19M HOAc	0.58M HOAc	0.006M Cr(OAc) ₃	0.025M Cr(OAc) ₃
15	0.12	-	-	2.1	2.15	0.27
100	0.14	0.21	0.38	2.4	0.19	0.40
160	0.16	0.22	0.40	2.5	0.22	0.45
330	0.21	0.23	0.42	2.7	0.26	0.55

Cr CHROMIUM

PO CHROMIC PHOSPHATE CrPO_4

The K_{ap} of green CrPO_4 is 2.4×10^{-23} at $18-20^\circ$.

" " " violet CrPO_4 is 1.0×10^{-17} at $18-20^\circ$. (Zharovskii, 1951)

THE SYSTEM CHROMIC OXIDE - PHOSPHORUS PENTOXIDE - WATER
(Jameson and Salmon, 1955)

Air thermostats were used at both temperatures.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
P ₂ O ₅	Cr ₂ O ₃		P ₂ O ₅	Cr ₂ O ₃	
Results at 0°					
0.981	0.101	Cr ₂ O ₃ · P ₂ O ₅ · 12H ₂ O	18.70	3.13	2Cr ₂ O ₃ · 3P ₂ O ₅ · 51H ₂ O
1.352	0.153	"	20.21	3.26	"
2.50	0.325	"	23.22	3.77	"
3.76	0.578	"	25.66	3.53	Cr ₂ O ₃ · 2P ₂ O ₅ · 19H ₂ O
4.47	0.647	"	28.01	3.18	"
5.09	0.933	"	28.41	3.19	"
6.22	1.31	"	30.98	2.91	"
7.48	1.68	"	33.90	2.65	"
7.59	1.77	"	38.06	2.54	"
8.99	2.24	2Cr ₂ O ₃ · 3P ₂ O ₅ · 51H ₂ O	41.96	2.53	"
9.88	2.24	"	44.03	1.95	Cr ₂ O ₃ · 3P ₂ O ₅ · 18H ₂ O
10.81	2.36	"	44.91	1.86	"
12.42	2.53	"	47.23	1.48	"
14.22	2.77	"	47.41	1.47	"
15.68	2.87	"	49.79	1.26	"
17.85	3.03	"	51.77	1.17	"
Results at 40°					
0.870	0.051	Cr ₂ O ₃ · P ₂ O ₅ · 12H ₂ O	29.87	7.10	Cr ₂ O ₃ · 2P ₂ O ₅ · 8H ₂ O
1.932	0.143	"	33.01	7.43	"
3.44	0.340	"	35.35	7.82	"
4.22	0.494	"	38.83	8.44	"
7.43	1.24	"	41.96	9.39	"
9.22	1.57	"	43.11	9.81	"
11.13	2.66	"	45.63	10.38	Cr ₂ O ₃ · 3P ₂ O ₅ · 10H ₂ O
12.63	3.77	"	47.21	8.61	"
15.88	6.18	"	49.11	7.57	"
17.34	8.34	"	50.54	6.71	"
18.84	9.19	"	51.76	5.97	"
20.72	8.95	Cr ₂ O ₃ · 2P ₂ O ₅ · 8H ₂ O	54.89	5.07	"
22.45	8.20	"	56.13	4.98	"
25.24	7.48	"			

As part of a study of the system $\text{Cr}_2\text{O}_3 + \text{ZnO}$, Huttig and Theimer (1941) determined the solubility of Cr_2O_3 in dilute HCl and H_2SO_4 after the oxide had been heated to various temperatures.

The following systems have been investigated:

$\text{Cr}_2\text{O}_3 + \text{NiO}$	(1:1 compound)	Thomassen (1940)
$\text{Cr}_2\text{O}_3 + \text{NiO} + \text{ZrO}_2$	(by X-Rays)	Milligan and Watt (1948)
$\text{Cr}_2\text{O}_3 + \text{Fe}_2\text{O}_3$	(as gels)	Milligan and Merten (1947)
$\text{Cr}_2\text{O}_3 + \text{Cu}_2\text{O}$		Schenck and Keuth (1940)

CHROMIOUS SULFATE CrSO_4

50

At 0° 12.35 gms. (of hydrate?) dissolve in 100 gms. H_2O . Solid phase $\text{CrSO}_4 \cdot 7\text{H}_2\text{O}$ (Moissan, 1882).

CHROMIC SULFATE $\text{Cr}_2(\text{SO}_4)_3$

50

THE SYSTEM $\text{Cr}_2(\text{SO}_4)_3 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ AT 25°
(Taylor, 1953)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Cr}_2(\text{SO}_4)_3$	H_2SO_4		$\text{Cr}_2(\text{SO}_4)_3$	H_2SO_4	
39.05	0.0	$\text{Cr}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}\alpha$	17.10	24.27	$\text{Cr}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}\beta$
30.80	7.06	"	13.52	31.08	$\text{Cr}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$
26.51	11.68	"	8.48	38.26	"
23.15	15.90	$\text{Cr}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}\beta$	7.31	43.21	"
19.70	20.73	"			

CHROMIUM POTASSIUM SULFATE

50

CHROMIUM TELLURIUM SULFATE (alums)

SOLUBILITY OF CHROMIUM ALUMS IN WATER AT 25°
(Locke, 1901)

Alum	Formula	Per 100 cc Water		
		Grams Anhydrous	Grams Hydrated	Gram Mols.
Potassium Chromium Alum	$\text{K}_2\text{Cr}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	12.51	24.39	0.0441
Tellurium Chromium Alum	$\text{Te}_2\text{Cr}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	10.41	16.38	0.0212

Cr CHROMIUM

SO CHROMIUM AMMONIUM SULFATE $\text{Cr}(\text{NH}_4)(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (Alum)

SOLUBILITY IN WATER (Koppel, 1906)

It was shown that, due to the transition between the violet and green forms of the compound, the saturation point is reached very slowly, especially at the higher temperatures. From the determinations at 0° it was found that equilibrium is reached in $2\frac{1}{2}$ hours. If this saturation time is taken for the other temperatures, the results are considered to show the solubility of the violet form alone. The final saturation represents the attainment of an equilibrium between the violet and green forms.

Results for the Violet Form			Results for Final Equilibrium		
t°	Time of Saturation, Hrs.	Gms. $(\text{NH}_4)\text{Cr}(\text{SO}_4)_2$ per 100 Gms. Sol.	t°	Time of Saturation, Hrs.	Gms. $(\text{NH}_4)\text{Cr}(\text{SO}_4)_2$ per 100 Gms. Sol.
0	2.5	3.8	0	2.5	3.8
30	2.5	10.6	25	-	13.66 ¹
40	2.5	15.5		-	10.78 ²
			30	300	15.7-16
			40	250	24.5-24.8

¹Smith and Lennox, 1948; ²Locke, 1901 (gms. per 100 cc H₂O)

EQUILIBRIUM IN THE SYSTEMS

CHROMIUM AMMONIUM SULFATE - IRON AMMONIUM SULFATE - WATER AND
CHROMIUM AMMONIUM SULFATE - ALUMINUM AMMONIUM SULFATE - WATER AT 25°
(Smith and Lennox, 1948)

Each pair of alums exhibits continuous solid solutions of Roozeboom's Type I. Each point was established by duplicate determinations, in which the order of addition of the salts was reversed. The solid solutions contain 12 molecules of water per mol. of salts.

CHROMIUM - IRON ALUMS

Saturated Solution		Solid Phase	
Wt. % $\text{Cr}(\text{NH}_4)(\text{SO}_4)_2$	Wt. % $\text{Fe}(\text{NH}_4)(\text{SO}_4)_2$	Wt. % $\text{Cr}(\text{NH}_4)(\text{SO}_4)_2$	Wt. % $\text{Fe}(\text{NH}_4)(\text{SO}_4)_2$
0.0	31.20	0.0	55.17
0.332	29.55	3.789	50.46
0.745	28.71	7.992	47.13
1.153	27.58	11.45	41.21
1.788	25.62	17.26	37.20
2.692	23.29	23.55	31.34
4.546	19.02	33.39	20.18
7.402	12.09	44.26	10.39
10.30	6.081	49.68	4.562
13.66	0.0	54.81	0.0

CHROMIUM - ALUMINUM ALUMS

Saturated Solution		Solid Phase	
Wt. % $\text{CrNH}_4(\text{SO}_4)_2$	Wt. % $\text{AlNH}_4(\text{SO}_4)_2$	Wt. % $\text{CrNH}_4(\text{SO}_4)_2$	Wt. % $\text{AlNH}_4(\text{SO}_4)_2$
0.0	6.15	0.0	52.31
2.761	4.826	6.44	46.27
5.318	3.478	15.67	37.05
8.00	2.374	25.94	27.31
10.19	0.967	37.14	19.61
11.98	0.610	43.99	8.99
13.66	0.0	54.81	0.0

CESIUM Cs

At -50° a saturated solution in liquid NH_3 contains 77.05 wt. % Cs. (Hodgins, 1949)

Melting point data in the systems Cs-CsF, Cs-CsCl and Cs-CsI are given by Bredig, Bronstein, and Smith, Jr. (1955)

Data for the systems Cs + K and Cs + Na are given by Gorla (1935).

CESIUM Penta BORATE $\text{Cs}_2\text{O} \cdot 5\text{B}_2\text{O}_3$

80

SOLUBILITY OF CESIUM PENTABORATE IN WATER

(Rollet and Andres, 1930, 1931)

t°	Gms. $\text{Cs}_2\text{O} \cdot 5\text{B}_2\text{O}_3$ per 100 gms. sat. sol.	Solid Phase
-0.36 (Eutec.)	1.59	$\text{Cs}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$
5	1.68	"
18.	2.33	"
30.	3.52	"
45.	5.57	"
60.	8.31	"
75.	12.0	"
80	13.8	"
89.4	17.85	"
93	19.5	"
95	20.4	"
99.1	22.3	"
101.65	23.45	"
102. (b. pt.)		

Cs CESIUM

Br CESIUM BROMIDE CsBr

SOLUBILITY OF CESIUM BROMIDE IN WATER

t°	Gms. CsBr per 100 gms. sat. sol.	Authority
18	51.84	Lannung, 1934
25	55.23	Foote, 1907
25	55.24	Meyer and Dunkel, 1931

THE SYSTEM CESIUM BROMIDE - LEAD BROMIDE - WATER AT 25° (Foote, 1907)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
CsBr	PbBr ₂		CsBr	PbBr ₂	
0.24	0.33	PbBr ₂ + CsPb ₂ Br ₃	33.65	trace	CsPbBr ₃
0.33	0.36	" "	36.7	"	" + Cs ₄ PbBr ₆
12.83	trace	CsPb ₂ Br ₃	46.4	"	Cs ₄ PbBr ₆
17.24	"	"	51.15	"	"
17.68	"	" + CsPbBr ₃	54.4	"	" + CsBr
18.58	"	CsPbBr ₃	55.23	0	CsBr

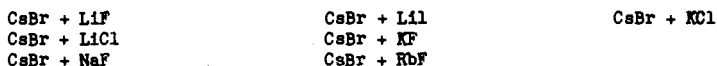
SOLUBILITY OF CESIUM BROMIDE IN OTHER SOLVENTS

Solvent	t°	Gms. CsBr per 100 Gms. solvent sat. sol.	Density	Author
Acetone	18	0.00403	0.792	(Lannung, 1932)
	37	0.00406	0.770	(" ")
Acetonitrile	18	0.10	0.785	(Pavlopoulos and Strehlow, 1954)
	25	0.14	0.782	(" " " ")
Methanol	18	2.2	0.806	(" " " ")
	25	2.3	0.801	(" " " ")
Formic acid	18	69.6	1.743	(" " " ")
	25	71.7	1.749	(" " " ")
Liquid NH ₃	0	4.58	-	(Linhard and Stephan, 1933, 1934)

THE TERNARY SYSTEMS CESIUM BROMIDE - IODINE - TOLUENE AND CESIUM BROMIDE - IODINE - BENZENE AT 6° (Foote and Fleischer, 1940)

CsBr - I ₂ - Toluene			CsBr - I ₂ - Benzene		
Gms. I per 100 gms. Sat. Sol.	Solid Phase		Gms. I per 100 gms. Sat. Sol.	Solid Phase	
0.98	CsBr + CsBrI ₂		0.82	CsBr + CsBrI ₂	
1.51	CsBrI ₂		1.43	CsBrI ₂	
9.63	"		5.82	"	
10.36	CsBrI ₂ + I ₂		7.74	"	
			8.69	CsBrI ₂ + I ₂	

Reactions between the dry salts below their melting points have been studied by Link and Wood, 1940 for the following:



The equilibrium concentrations of the salts in the reaction $\text{CsBr} + \text{KCl} \rightleftharpoons \text{CaCl} + \text{KBr}$ at 400° and 477° were determined by Vogt and Wood (1944). The concentrations were found by means of X-Rays.

CESIUM Iodo Di BROMIDE CsIBr_2

Br

100 gms. sat. sol. of Cesium Iodo dibromide in water contain 4.45 gm. CsIBr_2 at 20°. (Wells, quoted by Cremer and Duncan, 1931)

The solubility of Cesium Iodo dibromide in Carbon Tetrachloride is given by Cremen and Duncan, 1931, as 0.00014 normal (?) at 25°.

CESIUM MERCURIC BROMIDE $\text{CsBr} \cdot 2\text{HgBr}_2$

100 grams saturated aqueous solution contain 0.807 gram $\text{CsBr} \cdot 2\text{HgBr}_2$ at 15°. (Wells, 1892)

CESIUM BROMATE CsBrO_3

BrO

SOLUBILITY OF CESIUM BROMATE IN WATER (McCrosky and Buell, 1920; Buell and McCrosky, 1921)

t°	Gms. CsBrO_3 per 100 gms. H_2O	Solid Phase
25	3.66	CsBrO_3
30	4.53	"
35	5.32	"

CESIUM METHIONATE $\text{Cs}[\text{CH}_2(\text{SO}_3)_2]$

CH

CESIUM Chlor METHIONATE $\text{Cs}[\text{CHCl}(\text{SO}_3)_2]$

100 gms. H_2O dissolve 21.4 gms. $\text{Cs}[\text{CH}_2(\text{SO}_3)_2]$ at 25°. (Backer, 1930)
 " " " " 51.2 " $\text{Cs}[\text{CHCl}(\text{SO}_3)_2]$ at 25°. (Backer, 1930)

Cs CESIUM

CH CESIUM FORMATE HCOOCs

SOLUBILITY OF CESIUM FORMATE IN WATER (Sidgwick and Gentle, 1922)

t°	Gms. HCOOCs per 100 gms. sat. sol.	Solid Phase	t°	Gms. HCOOCs per 100 gms. sat. sol.	Solid Phase
-0.77	4.00	Ice	42.7	88.67	$\text{HCOOCs} \cdot \text{H}_2\text{O}$
-1.72	8.11	"	44.6	90.42	"
-3.44	14.29	"	45.0 m.pt.	-	"
-5.27	19.62	"	43.8	92.54	"
-8.12	26.75	"	42.6	93.47	"
+1.0	77.07	$\text{HCOOCs} \cdot \text{H}_2\text{O}$	41.0 tr. pt.	-	" + HCOOCs
21.0	81.69	"	95.4	95.27	HCOOCs
26.2	83.25	"	161.6	96.67	"
32.2	84.81	"	265.0 m. pt.	100.00	"
39.2	86.88	"			

CH CESIUM ACETATE CH_3COOCs

SOLUBILITY OF CESIUM ACETATE IN WATER (Sidgwick and Gentle, 1922)

t°	Gms. CH_3COOCs per 100 gms. sat. sol.	Solid Phase	t°	Gms. CH_3COOCs per 100 gms. sat. sol.	Solid Phase
- 1.36	6.63	Ice	+ 21.5	91.06	CH_3COOCs
- 5.32	19.38	"	61.1	91.98	"
- 7.92	25.26	"	88.6	93.09	"
-13.07	34.22	"	133.8	95.78	"
- 2.5	89.71	CH_3COOCs	194.0 m. pt.	100.00	"

CESIUM DihydroxyTARTRATE $\text{Cs}_2\text{C}_4\text{H}_4\text{O}_8 \cdot 2\text{H}_2\text{O}$

100 gms. H_2O dissolve 22.5 gms. $\text{Cs}_2\text{C}_4\text{H}_4\text{O}_8 \cdot 2\text{H}_2\text{O}$ at 0°. (Fenton, 1898)

CESIUM PICRATE, CESIUM BI TARTRATE, etc.

SOLUBILITY OF EACH IN WATER AT 20° (Moser and Ritschel, 1925)

Compound	Formula	Gms. compd. per 1000 cc sat. sol.
Cesium picrate	$\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OCs}$	3.08
Cesium bitartrate	$\text{Cs} \cdot \text{HC}_4\text{H}_4\text{O}_6$	71.13
Cesium silicomolybdate	-	0.4
Cesium phosphotungstate	-	0.04

CESIUM BENZOATE C_6H_5COOCs

CH

SOLUBILITY OF CESIUM BENZOATE IN WATER
(Sidgwick and Ewbank, 1922)

t°	Gms. C_6H_5COOCs per 100 gms. sat. sol.	Solid Phase
- 1.22	9.92	Ice
- 4.44	25.62	"
-10.81	43.08	"
+12.0	74.75	C_6H_5COOCs
53.5	77.34	"
124.0	81.51	"

SOLUBILITY OF CESIUM ORTHO, META AND PARA HYDROXY BENZOATES IN WATER
(Sidgwick and Ewbank, 1922)Results for Cesium
Ortho Hydroxy Benzoate

t°	Gms. $C_6H_4(OH)COOCs$ per 100 gms. sat. sol.	Solid Phase
-1.83.	16.08	Ice
-4.24.	30.97	"
-8.08.	47.71	"
-3.5..	65.70	ol-1
+4.5..	68.24	"
20.5..	70.59	"
33.0..	80.07	"
41.5..	83.35	ol- $\frac{1}{2}$ *
54.0..	85.67	"
67.5..	89.91	"
84.3..	92.80	ol-0
107.5..	94.33	"

Results for Cesium
Meta Hydroxy Benzoate

t°	Gms. $C_6H_4(OH)COOCs$ per 100 gms. sat. sol.	Solid Phase
- 1.97.	16.98	Ice
- 4.92.	32.84	"
- 9.65.	48.53	"
-18.50.	63.15	"
+10.0..	77.10.	ml-x
19.0..	78.52	"
29.0..	81.70	"
35.0..	84.45	"
40.0..	86.35	"
41.5..	87.88	ml-0*
73.0..	89.88	"
126.5..	93.42	"

Results for Cesium Para Hydroxy Benzoate

t°	Gms. $C_6H_4(OH)COOCs$ per 100 gms. sat. sol.	Solid Phase	t°	Gms. $C_6H_4(OH)COOCs$ per 100 gms. sat. sol.	Solid Phase
-1.56.	14.34	Ice	75.5..	60.36	pl-0
-2.42.	20.38	"	90.3..	65.35	"
-4.27.	29.57	"	107.5..	70.67	"
+3.5..	29.57	pl-1	118.0..	73.84	"
27.5..	40.80	"	136.0..	79.88	"
49.0..	50.01	"			

ol-1 = $oC_6H_4(OH)COOCs \cdot H_2O$; ol- $\frac{1}{2}$ = $oC_6H_4(OH)COOCs \cdot \frac{1}{2}H_2O$; ol-0 = $oC_6H_4(OH)COOCs$;
 ml-x = $mC_6H_4(OH)COOCs \cdot xH_2O$; ml-0 = $mC_6H_4(OH)COOCs$;
 pl-1 = $pC_6H_4(OH)COOCs \cdot H_2O$; pl-0 = $pC_6H_4(OH)COOCs$. *Unstable

CS CESIUM

CH CESIUM BENZENE SULFONATES

SOLUBILITY OF CESIUM BENZENE SULFONATES IN WATER AT 25°
(Elgerama, 1929)

Compound	Formula	Gme. compound per 100 gma. H ₂ O
Cesium o Nitro Benzene Sulfonate	Cs[NO ₂ ·C ₆ H ₄ SO ₃]	20.74
" m " " "	"	more than 37.00
" p " " "	"	5.46
" o, p Dinitro " "	Cs[(NO ₂) ₂ C ₆ H ₃ SO ₃]	2.50
" o Nitro p Chlor " "	Cs[(NO ₂) ₂ C ₆ H ₃ ClSO ₃]	6.98
" 2 " 5 " " "	"	2.25
" 3 " 6 " " "	"	1.51
" 2 " 4 Brom " "	Co[(NO ₂) C ₆ H ₃ BrSO ₃]	6.09

CESIUM MANDELATE

EQUILIBRIUM IN THE SYSTEM CESIUM MANDELATE, MANDELIC ACID AND WATER AT 25°
(Roes and Morrison, 1936; Ross, Morrison and Johnstone, 1937)

Results for Ranemic Mandelic Acid
(dl)C₆H₅CH(OH)COOH

Results for Laevo
Mandelic Acid
(l)C₆H₅CHOHCOOH(-)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
C ₆ H ₅ O ₃	CsC ₆ H ₇ O ₃	Solid Phase	C ₆ H ₅ O ₃	CsC ₆ H ₇ O ₃	Solid Phase	C ₆ H ₅ O ₃	CsC ₆ H ₇ O ₃	Solid Phase
16.95	0.0	C ₆ H ₅ O ₃	50.8	25.6	C ₆ H ₅ O ₃	10.1	0.0	C ₆ H ₅ O ₃
17.3	0.4	"	51.3	27.2	"	10.3	2.8	"
18.4	1.4	"	52.5	30.7	"	11.0	5.0	"
20.1	2.8	"	52.5	32.2	1:1 salt	12.0	7.1	"
22.6	4.5	"	47.3	31.9	"	14.5	11.3	"
25.6	6.3	"	44.3	31.1	"	25.0	19.0	"
29.1	9.0	"	32.1	32.6	"	34.9	24.3	"
33.7	12.3	"	29.1	33.4	"	42.8	30.3	"
39.4	15.3	"	16.1	40.6	"	44.6	32.3	"
45.2	18.3	"	5.3	53.8	"	49.4	39.4	"
47.4	20.7	"	2.9	67.3	"	49.2	42.0	"
49.2	22.2	"	3.7	79.2	"			

1:1 salt = C₆H₅O₃·C₆H₇O₃Cs

*Owing to the viscosity of the concentrated solutions it was impossible to get additional points or obtain an acid 1:1 salt as solid phase.

CH CESIUM DIPICRYLAMINATE Cs[(NO₂)₃C₆H₂NHC₆H₂(NO₂)₃]

SOLUBILITY IN WATER
(Treadwell and Hepenstrick, 1949)

20°	176	Mg. per liter
25°	257	"

CESIUM CARBONATE Cs_2CO_3

CO

100 grams absolute alcohol dissolve 11.1 grams Cs_2CO_3 at 19°, and 20.1 grams at b. pt. (Bunsen)

CESIUM BICARBONATE CsHCO_3

100 grams sat. solution in H_2O contain 67.8 grams CaHCO_3 at about 20°. (de Forcaud, 1909)

CESIUM OXALATE $\text{Cs}_2\text{C}_2\text{O}_4$

CO

THE SYSTEM CESIUM OXALATE - OXALIC ACID - WATER AT 25°
(Foote and Andrew, 1905)

Varying amounts of the two substances were dissolved in hot water and the solutions allowed to cool in a thermostat held at 25°.

Gms. per 100 Gms. Solution		G. Mols. per 100 G. Mols. H_2O		Solid Phase
$\text{H}_2\text{C}_2\text{O}_4$	$\text{Cs}_2\text{C}_2\text{O}_4$	$\text{H}_2\text{C}_2\text{O}_4$	$\text{Cs}_2\text{C}_2\text{O}_4$	
10.20	...	2.274	...	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
10.29	0.61	2.314	0.035	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} + \text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
7.90	9.92	1.924	0.614	Double Salt
4.11	25.12	1.162	1.81	$\text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
4.32	27.55	1.279	2.06	$\text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O} + \text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3$
4.27	28.30	1.267	2.14	Double Salt
4.40	35.90	1.476	3.07	$\text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3$
4.82	40.10	1.752	3.71	$\text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3 + \text{HCsC}_2\text{O}_4$
4.45	42.32	1.672	4.05	Double Salt
3.05	48.80	1.268	5.16	HCsC_2O_4
1.04	68.69	0.688	11.56	$\text{HCsC}_2\text{O}_4 + \text{H}_6\text{Cs}_8(\text{C}_2\text{O}_4)_7$
0.91	71.24	0.648	13.06	Double Salt
0.77	73.45	0.598	14.51	$\text{H}_6\text{Cs}_8(\text{C}_2\text{O}_4)_7$
0.75	74.04	0.596	14.96	$\text{H}_6\text{Cs}_8(\text{C}_2\text{O}_4)_7 + \text{Cs}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$
0.74	75.20	0.625	15.93	$\text{Cs}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$
0.0	75.82	0.0	15.97	

Svetsuna (1952) reports the solubility of $\text{CsH}_3(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$ to be 4.34 gms. of the salt per 100 gms. H_2O at 21°.

Cs CESIUM

CO EQUILIBRIUM IN THE SYSTEM CESIUM OXALATE, ZIRCONYL OXALATE AND WATER AT 19° (Boulanger, 1936)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
(COOCS) ₂	(COO) ₂ ZrO		(COOCS) ₂	(COO) ₂ ZrO	
33.98	0.0	CsC ₂ O ₄ ·H ₂ O	15.0	1.80	2.1.1.4
32.0	trace	1.1.1.3(?)	14.57	2.22	"
25.1	0.6	"	14.5	2.4	"
22.6	0.82	"	12.17	2.19	(?)
19.83	0.97	"	10.0	1.8	"
19.05	1.02	"	7.58	1.3	"
17.02	1.29	2.1.1.4	5.0	1.02	"

1.1.1.3 = (COOCS)₂·(COO)₂ZrO·(COOH)₂·3H₂O;
 2.1.1.4 = 2(COOCS)₂·(COO)₂ZrO·(COOH)₂·4H₂O.

CESIUM Telluracid OXALATE Cs₂[H₆TeO₆·C₂O₄]

100 gms. H₂O dissolve 6.42 gms. Cs₂[H₆TeO₆·C₂O₄] at 0°, 12.39 gms. at 20°, 15.08 gms. at 30°, 19.78 gms. at 40° and 27.66 gms. at 50°. (Rosenheim and Weinheber, 1910-11).

CI CESIUM CHLORIDE CsCl

(Berkeley, 1904; also: Hinrichsen and Sachsels, 1904-05; Foote, 1903; Malquori, 1926; Meyer and Dunkel, 1931; Lannung 1934; Blidin, 1953)

t°	G. CsCl per 100 Gms.		G. Mol. CsCl per Liter	t°	G. CsCl per 100 Gms.		G. Mol. CsCl per Liter
	Solution	Water			Solution	Water	
0	61.7	161.4	6.74	50	68.6	218.5	8.07
10	63.6	174.7	7.11	60	69.7	229.7	8.28
15	64.75	(M.)	-	70	70.6	239.5	8.46
18	65.23	(L.)	-	80	71.4	250.0	8.64
25	65.55	(Bl., F, M. and D.)	-	90	72.2	260.1	8.80
20	65.1	186.5	7.38	100	73.0	270.5	8.96
30	66.4	197.3	7.63	119.4	74.4	290.0	9.22
40	67.5	208.0	7.86				
	67.40	(Bl.)					

A saturated solution of CsCl in conc. HCl (d = 1.19) at 20° is 4.725 molar (Meier and Treadwell, 1951).

THE SYSTEM CESIUM CHLORIDE - LITHIUM CHLORIDE - WATER AT 25°
(Blidin, 1953)

Results at 25°

Gms. per 100
gms. sat. sol.

LiCl	CsCl	Solid Phase
45.95	0.0	LiCl·H ₂ O
42.24	5.52	"
39.76	11.48	"
36.38	16.54	"
32.63	26.47	"
29.81	36.71	"
29.03	40.65	" + 2CsCl·LiCl·4H ₂ O
26.38	44.26	2CsCl·LiCl·4H ₂ O
21.48	47.65	"
18.24	49.84	"
15.86	51.92	" + CsCl
10.12	55.63	CsCl
3.50	61.48	"
0.0	65.51	"

Results at 40°

Gms. per 100
gms. sat. sol.

LiCl	CsCl	Solid Phase
47.98	0.0	LiCl·H ₂ O
46.04	3.91	"
43.75	7.46	"
40.02	14.63	"
37.56	23.34	"
35.71	30.12	"
33.62	37.05	" + 2CsCl·LiCl·4H ₂ O
30.73	39.97	2CsCl·LiCl·4H ₂ O
24.49	45.83	"
19.80	48.65	"
15.67	52.24	" + CsCl
12.46	53.68	CsCl
6.50	58.76	"
0.0	67.40	"

THE SYSTEM CESIUM CHLORIDE - MERCURIC CHLORIDE - WATER AT 25°
(Foote, 1903)

Gms. per
100 Gms.
Sat. Solution

CsCl	HgCl ₂	Solid Phase
65.61	0.0	CsCl
65.78	0.215	CsCl + Cs ₃ HgCl ₅
52.36	0.32	Double Salt Cs ₃ HgCl ₅ = 65.1% CsCl
57.01	0.64	
52.35	1.23	
51.08	1.44	
49.30	1.49	Double Salt Cs ₂ HgCl ₄ = 55.4% CsCl
45.95	1.69	
45.23	1.73	

Gms. per
100 Gms.
Sat. Solution

CsCl	HgCl ₂	Solid Phase
38.63	1.32	Double Salt CsHgCl ₃ = 38.3% CsCl
17.03	0.51	
1.53	0.42	
0.61	2.64	CsHgCl ₃ + CsHg ₂ Cl ₅
0.49	2.91	Double Salt CsHg ₂ Cl ₅ = 23.7% CsCl
0.40	3.78	
0.44	4.63	CsHg ₂ Cl ₅ + CsHg ₃ Cl ₁₁
0.41	4.68	Double Salt CsHg ₃ Cl ₁₁ = 11.1% CsCl
0.25	5.65	
0.18	7.09	
0.0	6.90	CsHg ₃ Cl ₁₁ + HgCl ₂

Cs CESIUM

THE SYSTEM CESIUM CHLORIDE - MERCURIC CHLORIDE - ACETONE AT 25° (Foote, 1911)

Gms. per 100 Gms. Solution			Gms. per 100 Gms. Solution		
CsCl	HgCl ₂	Solid Phase	CsCl	HgCl ₂	Solid Phase
0.032	0	CsCl	0.48	28.48	CsCl·2HgCl ₂
0.11	0.02	Mixed salts	0.48	39.65	"
0.19	0.16	"	0.47	44.40	" + CsCl·5HgCl ₂
0.25	0.17	"	0.32	49.83	CsCl·5HgCl ₂
0.45	13.08	CsCl·HgCl ₂	0.20	57.74	"
0.46	21.50	"	0.13	57.76	" + HgCl ₂
0.56	27.2	" + CsCl·2HgCl ₂	0.0	57.74	HgCl ₂

THE SYSTEM CESIUM CHLORIDE - MAGNESIUM CHLORIDE - WATER AT 25° (D'Ans and Busch, 1937)

Gm. mols. per 1000 mols. H ₂ O		
CsCl	MgCl ₂	Solid Phase
71.7	55.5	CsCl + CsCl·MgCl ₂ ·6H ₂ O
39.6	64.8	CsCl·MgCl ₂ ·6H ₂ O
3.3	88.0	"
1.0	104.8	" + MgCl ₂ ·6H ₂ O

THE SYSTEM CESIUM CHLORIDE - THALLIC CHLORIDE - WATER AT 15° (Malquori, 1926)

Constant agitation in a thermostat was employed. The solid phases were identified by the "rest method" of Schreinemakers.

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
TlCl ₃	CsCl	H ₂ O		TlCl ₃	CsCl	H ₂ O	
65.170	-	34.830	TlCl ₃ ·4H ₂ O	-	8.313	91.687	2.2.2
65.178	-	34.822	" + 2.3	-	12.450	87.550	"
61.180	-	38.820	2.3	-	20.020	79.980	"
54.913	-	45.087	"	-	26.930	73.070	"
50.127	-	49.873	"	-	27.173	72.827	" + 1.3.1
40.970	-	59.030	"	-	27.689	72.311	1.3.1
31.705	-	68.295	"	-	32.721	67.279	"
16.481	-	83.519	"	-	42.100	57.900	"
10.210	-	89.790	"	-	45.201	54.799	" + 1.3
6.573	0.021	93.406	"	-	45.910	54.090	1.3
1.451	1.123	97.426	"	-	50.00	50.0	"
0.739	2.371	96.900	"	-	58.170	41.830	"
0.017	3.201	96.782	"	-	63.981	36.019	"
	3.272	96.728	" + 2.2.2	-	64.713	35.287	" + CsCl
	3.272	96.718	2.2.2	-	64.750	35.250	CsCl

2.3 = 2TlCl₃·3CsCl; 2.2.2 = 2TlCl₃·2CsCl·2H₂O; 1.3.1 = TlCl₃·3CsCl·H₂O; 1.3 = TlCl₃·3CsCl.

Godeffroy, 1886 reports the solubility of the salt $3\text{CsCl} \cdot \text{TiCl}_3 \cdot 2\text{H}_2\text{O}$ to be 2.76 gms. per 100 gms. H_2O at 17° , and 33.3 gms. at 100° .

CESIUM Gold CHLORIDE CsAuCl_4

Cl

SOLUBILITY IN WATER
(Rosenblatt, 1886)

t°	Gms. CsAuCl_4 per 100 Gms. Solution	t°	Gms. CsAuCl_4 per 100 Gms. Solution	t°	Gms. CsAuCl_4 per 100 Gms. Solution
10	0.5	50	5.4	80	16.3
20	0.8	60	8.2	90	21.7
30	1.7	70	12.0	100	27.5
40	3.2				

CESIUM Iridium CHLORIDES Cs_2IrCl_6 , etc.

100 gms. H_2O dissolve 0.011 gm. cesium chloroiridate, Cs_2IrCl_6 at 19° .

100 gms. H_2O dissolve 0.05 gm. cesium hexachloroiridite, $\text{Cs}_3\text{IrCl}_6 \cdot 3\text{H}_2\text{O}$ at 19° .

100 gms. H_2O dissolve 0.83 gm. cesium aquopentachloroiridite, $\text{Cs}_2\text{Ir}(\text{H}_2\text{O})\text{Cl}_5$, at 19° .
(Delepine, 1908)

CESIUM Platinum CHLORIDE Cs_2PtCl_6

Cl

SOLUBILITY OF CESIUM PLATINUM CHLORIDE IN WATER
(Archibald and Hallett, 1925)

The authors consider that the higher values for this compound reported by Bunsen, are due either to hydrolysis or the presence of potassium compounds in the salt. Rosenheim and Weinheber, 1910-11 also give a high result: 100 gms. H_2O dissolve 0.135 gm. CsPtCl_4 at 20° .

t°	Gms. Cs_2PtCl_6 per 100 gms. H_2O	t°	Gms. Cs_2PtCl_6 per 100 gms. H_2O	t°	Gms. Cs_2PtCl_6 per 100 gms. H_2O
0	0.0047	40	0.0158	80	0.0525
10	0.0064	50	0.0212	90	0.0675
20	0.0086	60	0.0290	100	0.0915
30	0.0119	70	0.0389		

Cs CESIUM

CESIUM Rhenium CHLORIDE CsReCl_6

One liter Sat. solution of Cesium Rhenium Chloride in Aqueous 37% HCl contains 0.03 gm. CsReCl_6 at 0°.

One liter Sat. solution of Cesium Rhenium Chloride in Aqueous 20% H_2SO_4 contains 0.3 gm. CsReCl_6 at 18°. (Noddak and Noddak, 1933.)

Cl CESIUM Antimony CHLORIDES $3\text{CsCl} \cdot 2\text{SbCl}_3$; $\text{CsCl} \cdot \text{SbCl}_3$

SOLUBILITY OF $3\text{CsCl} \cdot 2\text{SbCl}_3$ IN HYDROCHLORIC ACID SOLUTIONS AT 25° (Bender, 1945)

It was found that the yellow or brown color sometimes assumed by this salt was due to traces of Thallium of the order of 0.005%.

Solvent			Solvent		
Gm. Moles HCl per 1000 gms. H_2O	Gms. $3\text{CsCl} \cdot 2\text{SbCl}_3$ per		Gm. Moles HCl per 1000 gms. H_2O	Gms. $3\text{CsCl} \cdot 2\text{SbCl}_3$ per	
	100 gms. Solvent	100 ml. Sat. Sol.		100 gms. Solvent	100 ml. Sat. Sol.
2.086	1.732	1.778	6.875	1.114	1.217
2.953	1.389	1.444	9.957	1.083	1.218
4.027	1.236	1.304	12.92	1.093	1.253
4.869	1.178	1.256	16.20	1.134	1.333

SOLUBILITY OF $\text{CsCl} \cdot \text{SbCl}_3$ IN HYDROCHLORIDE ACID SOLUTIONS AT 25° (Bender and Bunde, 1950)

Solvent:

Saturated Solution:

Moles HCl per 1000 gms. H_2O	Gms. $\text{CsCl} \cdot \text{SbCl}_3$ per 100	
	Gms. Sat. Sol.	cc Sat. Sol.
2.988	1.381	1.457
3.529	1.275	1.354
4.446	1.194	1.280
6.268	1.120	1.228
6.718	1.104	1.218
10.75	1.072	1.225
12.11	1.075	1.245

The authors also give data in the presence of varying amounts of AlCl_3 .

Cl CESIUM Tellurium CHLORIDE CsTeCl_6

SOLUBILITY IN AQUEOUS HYDROCHLORIC ACID (Wheeler, 1893)

100 parts HCl (Sp. Gr. 1.2) dissolve 0.05 part CsTeCl_6 at 22°.
100 parts HCl (Sp. Gr. 1.05) dissolve 0.78 part CsTeCl_6 at 22°.

SOLUBILITY OF CESIUM CHLORIDE IN ORGANIC SOLVENTS

(1) Kato and Hagiwara, 1950; (2) Pavlopoulos and Strehlow, 1954;
(3) Meier and Treadwell, 1951; (4) Lannung, 1932; (5) Foote, 1912.

Solvent	t°	Solubility of CsCl	Ref.
Methanol	18	3.39 gms./100 g. CH ₃ OH (d.=0.810)	(2)
	25	3.01 " (d.=0.813)	(2)
Ethanol	20	0.0029 moles per liter	(3)
1C ₂ H ₅ OH:5Conc. HCl (Sat'd. w. HCl gas)	20	0.0356 moles per liter	(3)
n-Butanol	16	11.5 mg. per liter	(1)
n-Amyl alcohol	18	8.0 mg. per liter	(2)
Acetonitrile	18	0.0083 gms./100 g. CH ₃ OH (d.=0.783)	(2)
	25	0.0084 " (d.=0.777)	(2)
Methyl acetate	20	16.5 mg. per liter	(1)
Ethyl acetate	19	1.4 mg. per liter	(1)
Diethyl acetate	19	9.1 mg. per liter	(1)
Butyric acid	20	11.1 mg. per liter	(1)
Formic acid	18	107.7 g./100 g. HCOOH (d.=1.896)	(2)
	25	130.5 " (d.=1.987)	(2)
Acetone	18	0.004 g./1000 g. acetone	(4)
	25	0.032 g./100 g. sat. sol.	(5)
	37	0.0044 g./1000 g. acetone	(4)

Cl

SOLUBILITY OF CESIUM CHLORIDE IN INORGANIC SOLVENTS

Solvent	t°	Solubility Gms. per 100 gms. sat. sol.	Author
Liquid SO ₂	25	0.294	(Shatenstein and Viktorov, 1937)
Liquid NH ₃	0	0.381	(Linhard and Stephan, 1933, 1934)
Selenium Oxychloride	25	3.83	(Wise, 1923)
		gms. per liter	
Phosphorus Oxychloride	20	1.26	(V. Gutman, 1952)

Melting point data are given for:

CsCl + CuCl	(1, 2)	CsCl + Cs ₂ SO ₄	(6, 12,)
" + TiCl ₃	(1, 2)	" + K ₂ SO ₄	(6)
" + LiCl	(3, 4, 12)	" + CsNO ₃	(13)
" + LiCl + NaCl	(4)	" + PbCl ₂	(11)
" + KCl	(5)	" + MgCl ₂	(8, 9)
" + RbCl	(5) (13)	" + ZnSO ₄	(10)
" + NaCl	(5)	" + CsVO ₃	(7)
" + RbNO ₃ ⇌ CsNO ₃ + RbCl	(13)	2CsCl + Li ₂ SO ₄ ⇌ Co ₂ SO ₄ + 2LiCl	(12)

(1) Sandonnini and Scarpa, 1912; (2) Sandonnini, 1914; (3) Korreng, 1915;
(4) Richards and Meldrum, 1917; (5) Zemczyny and Rambach, 1910; (6)
Dombrowskaya, 1933; (7) Schmitz-Dumont and Schmitz, 1944; (8) Markov and
Panchenko, 1954; (9) Markov and Panchenko, 1955; (10) Voskresenskaya and
Patsukova, 1955; (11) Gromakov, 1950; (12) Dergunov, 1951; (13) Blidin,
1953.

Cs CESIUM

Link and Wood, 1940 studied the reactions between the dry salts below the melting points for the following pairs:



C10 CESIUM CHLORATE CsClO_3

SOLUBILITY IN WATER

(Calzolari, 1912; see also Carlson, 1910)

t°	Gms. CsClO_3 per 100 gms. H_2O	t°	Gms. CsClO_3 per 100 gms. H_2O	t°	Gms. CsClO_3 per 100 gms. H_2O
0	2.46	30	9.5	70	34.7
10	3.8	40	13.8	80	45.0
20	6.2*	50	19.4	90	58.0
25	7.6	60	26.2	100	79.0

*Treadwell and Ammann (1938) found 6.3 gms. per 100 cc sat. sol.

C10 CESIUM PERCHLORATE CsClO_4

SOLUBILITY IN WATER

(Calzolari, 1912; see also Carlson, 1910)

t°	Gms. CsClO_4 per 100 gms. H_2O	t°	Gms. CsClO_4 per 100 gms. H_2O	t°	Gms. CsClO_4 per 100 gms. H_2O
0	0.8	30	2.6	70	9.8
10	1.0	40	4.0	80	14.4 (d=1.084)
20	1.6*	50	5.4	90	20.5
25	2.0 (d=1.010)†	60	7.3	100	30.0

*Moser and Ritschel, 1925 found 1.574 gms. per 100 cc sat. sol., Treadwell and Ammann found 1.6 gms. per 100 cc (both at 20°).

†Lange and Mueller, 1930 report 1.95 gms. per 100 cc at room temperature.

SOLUBILITY OF CESIUM PERCHLORATE IN AQUEOUS ETHYL ALCOHOL

(Flatt, 1923; Flatt and Jordan, 1930, 1933)

Solvent	t°	Gm. mols. CsClO_4 per 1000 cc solvent	Gms. CsClO_4 per 100 gms. solvent
Water	25	0.0848	1.974
42.5 Wt. % $\text{C}_2\text{H}_5\text{OH}$	25	0.0350	0.879
67.9 Wt. % $\text{C}_2\text{H}_5\text{OH}$	25	0.0136	0.365
50 Vol. % $\text{C}_2\text{H}_5\text{OH}$	40	-	1.522
75 Vol. % $\text{C}_2\text{H}_5\text{OH}$	40	-	0.635

SOLUBILITY OF CESIUM PERCHLORATE IN SEVERAL SOLVENTS AT 25°
(Willard and Smith, 1923)

ClO

Solvent	d of solvent	d of sat. sol.	Gms. CsClO ₄ per 100 gms. sat. sol.
Water	-	1.0165	1.93
Acetone	0.7859	0.7859	0.15
n Butyl alcohol	0.8059	0.8059	0.006
iso Butyl alcohol	0.7981	0.7981	0.007
Ethyl alcohol	0.7852	0.7852	0.011
Methyl alcohol	0.7874	0.7878	0.093
n Propyl alcohol	0.7993	0.7993	0.006

SOLUBILITY OF CESIUM PERCHLORATE IN MIXTURES OF ETHYL ACETATE
AND SEVERAL ALCOHOLS AT 25°
(Smith, 1925)

Solvent					Gms. CsClO ₄ per 100 gms. sat. sol.
10 vol. % of	Methyl alcohol	+ 90 vol. %	Ethyl acetate		0.0050
20	"	+ 80	"	"	0.0056
10	Ethyl	+ 90	"	"	0.0013
20	"	+ 80	"	"	0.0023
20	" 93%	+ 80	"	"	0.0040
10	" n Butyl	+ 90	"	"	0.0009
20	"	+ 80	"	"	0.0012

CESIUM CHROMATES, Cs₂CrO₄, Cs₂Cr₂O₇, etc.

CrO

THE SYSTEM CESIUM HYDROXIDE - CHROMIUM TRIOXIDE - WATER AT 30°
(Schreinemakers and Meijeringh, 1908)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
Cs ₂ O	CrO ₃		Cs ₂ O	CrO ₃	
70.63	0.0	CsOH·nH ₂ O	0.169	21.21	Cs ₂ Cr ₃ O ₁₀
69.22	0.119	" + Cs ₂ CrO ₄	0.096	25.59	"
36.06	1.883	Cs ₂ CrO ₄	1.89	36.19	"
31.00	7.523	"	2.79	41.68	"
31.68	9.652	"	3.29	44.23	"
35.80	13.08	"	±3.13	±44.45	" + Cs ₂ Cr ₄ O ₁₃
31.05	10.79	Cs ₂ Cr ₂ O ₇	2.96	44.66	Cs ₂ Cr ₄ O ₁₃
24.05	8.98	"	3.40	46.03	"
3.04	2.16	"	3.94	56.77	"
1.61	4.57	" + Cs ₂ Cr ₃ O ₁₀	4.35	62.70	" + CrO ₃
1.18	7.95	Cs ₂ Cr ₃ O ₁₀	2.33	62.50	CrO ₃
0.586	15.05	"	0	62.28	"

Melting points in the system CsCrO₄ - CsF are given by Schmitz-Dumont and Weeg, 1951.

Cs CESIUM

F CESIUM FLUORIDE CsF

SOLUBILITY IN WATER AT 18°

	Solid Phase	Author
85.36 gms. CsF per 100 gms. sat. sol.	CsF·H ₂ O (?)	(Lannung, 1934)
366.5 gms. CsF per 100 gms. H ₂ O	CsF·1½H ₂ O	(de Forcrand, 1911)
(78.5 gms. per 100 gms. sat. sol.)		

SOLUBILITY OF CESIUM FLUORIDE IN ACETONE

t°	Solubility Gms. per 1000 gms. Solvent	Author
18	0.0077 (d = .792)	(Lannung, 1932)
37	0.0087 (d = .770)	(" ")

SOLUBILITY OF CESIUM FLUORIDE IN HYDROGEN FLUORIDE
(Windsor and Cady, 1948)

Four compounds were found in the system, and the authors report the temperatures of their melting points, and of the eutectic points between them. All other data given below were read from the phase diagram given by the authors.

t°	Mol. % HF	Solid Phase	t°	Mol. % HF	Solid Phase
-50	83	CsF·6HF	30	70	CsF·2HF
-42.3(M.P.)	85.7	"	50.2(M.P.)	66.7	"
-49.5	82.8	CsF·6HF + CsF·3HF	38.3	63.9	CsF·2HF + CsF·HF
-30	82	CsF·3HF	60	60	CsF·HF
0	80	"	100	57	"
20	78	"	150	53	"
32.6(M.P.)	75.0	"	176.(M.P.)	50.0	"
16.9	70.9	CsF·3HF + CsF·2HF	151.5	45.3	CsF·HF + CsF

SOLUBILITY OF CESIUM FLUORIDE IN BROMINE TRIFLUORIDE
(Sheft, Hyman and Katz, 1953)

25°	3.68 gms. CsF per 100 gms. sat. sol.
70°	4.67 " " " " " " " "

COMPLEX CESIUM FLUORIDES CsMF_4 CsMF_6 , etc.

SOLUBILITIES IN WATER

Formula	t°	Solubility Gms. per 100 gms. H ₂ O	Authority
CsBF_4	20	1.64	(de Boer and Van Liempt, 1927)
CsGeF_6	0	0.84	(Muller, 1927)
"	10	0.98	(" ")
"	25	1.89	(" ")
"	30	2.28	(" ")
Cs_2TiF_6	20-22	2.5	(Ginsberg, 1932)
		Gms. per 100 mol solution	
Cs_2FtF_6	25	0.484	(Wheeler, Perros and Naeser, 1955)
CsPF_6	23	.839	(Lange and Muller, 1930)

SOLUBILITY IN ETHANOL

100 cc 98% Ethyl Alcohol, ($\text{C}_2\text{H}_5\text{OH}$) dissolve 0.002 gm. Cs_2TiF_6 at 20-22°. Ginsberg, 1932.

Melting point data are given for the following:

$\text{CsF} + \text{Cs}_2\text{MoO}_4$	(1)	$\text{CsF} + \text{CsVO}_3$	(3)
" + Cs_2CrO_4	(1)	" + AlF_3	(4)
" + Cs_2WO_4	(1)	" + LaF_3	(4)
" + ErF_3	(2)	" + YF_3	(4)
" + SmF_3	(2)	" + CsCO_3	(5)
" + PrF_3	(2)	" + Cs_2SO_4	(5)
" + CsTi_2O_5	(7)	" + MoO_3	(6)
		" + WO_3	(8)

- (1) Schmitz-Dumont and Weeg, 1951
- (2) Dergunov, 1952
- (3) Schmitz-Dumont and Schmitz, 1944
- (4) Dergunov, 1948
- (5) Schmitz-Dumont and Heckmann, 1949
- (6) Schmitz-Dumont and Heckmann, 1952
- (7) Schmitz-Dumont and Schulz, 1952
- (8) Schmitz-Dumont, Bruns and Heckmann, 1953

The reactions below the melting points were determined for the following solid salt pairs by Link and Wood, 1940.

$\text{CsF} + \text{LiCl}$	$\text{CsF} + \text{NaCl}$	$\text{CsF} + \text{KCl}$	$\text{CsF} + \text{RbCl}$
$\text{CsF} + \text{LiBr}$	$\text{CsF} + \text{NaBr}$	$\text{CsF} + \text{KBr}$	$\text{CsF} + \text{RbBr}$
$\text{CsF} + \text{LiI}$	$\text{CsF} + \text{NaI}$	$\text{CsF} + \text{KI}$	$\text{CsF} + \text{RbI}$

Cs CESIUM

I CESIUM IODIDE CsI

SOLUBILITY IN WATER
(Briggs and Hubbard, 1941)

The authors determined the solubility in water at many temperatures, and present a table of data which includes the work of previous investigators.

t°	Gms. CsI per 100 gms. sat. sol.	Solid Phase	t°	Gms. CsI per 100 gms. sat. sol.	Solid Phase
-1.2	8.76	Ice	25.0	46.1 (6)	CsI
-2.7	18.75	"	25.0	46.9 (7)	"
-4.0	27.45	Ice + CsI	32.0	49.98	"
-4.0	27.69 (1)	"	32.4	50.05	"
0.0	30.6 (2)	CsI	35.6	51.48 (1)	"
1.4	31.41	"	45.9	55.54	"
9.3	36.90	"	59.3	60.43	"
14.0	39.8 (2)	"	61.0	60.0 (2)	"
15.0	40.3 (3)	"	61.3	60.75	"
18.0	41.13 (4)	"	77.7	65.24	"
19.4	43.32	"	88.0	67.16	"
22.8	47.94 (5)	"	102.8	70.25	"
			109.1	71.48 (Boiling Point)	

- (1) Foote, Am. Chem. J. 29, 203 (1903)
- (2) Beketoff, Bull. Acad. St. Petersburg [4] 4. 198 (1894)
- (3) Setterberg, in Gemelin's Handbuch der anorganischen Chemie, System, Nr. 25 (Cesium) Vol. 2, p. 200; Berlin, 1938.
- (4) Lannung, Z. physik. Chem. A170, 134 (1934)
- (5) Buchanan, Am. J. Sci. [4] 21, 32 (1906)
- (6) Briggs, Greenwald, and Leonard, J. Phys. Chem. 34, 1951 (1930)
- (7) Fajans and Karagunis, from Meyer and Dunkel; Z. physik. Chem., Bodenstern festband, p. 556 (1931)

THE SYSTEM CESIUM IODIDE - IODINE - WATER
(Briggs and Hubbard, 1941)

Below 51.5°, the diagram of the system consists of the saturation curves of the four solid phases: CsI, CsI₂, CsI₃, and I₂. Above this temperature the curves are interrupted by a solid immiscibility gap, and in certain mixtures there are two different liquid phases in equilibrium. As the temperature is increased, the solids become more soluble, and the two-liquid region covers a major part of the diagram. Above 80.7° Cesium Salts become so soluble that their saturation curves no longer intersect the liquid immiscibility gap, and there is again only one liquid phase in the system.

The boiling points of the various solutions were determined and are presented in a diagram. CsI₃ is congruently soluble above 80°, and CsI₄ from 79.5° to 89°. The data agree with those of Foote (1903), Briggs (1930), and Briggs and Greenwald (1930), except that the Penta-iodide of Foote has since been shown to be the Tetra-iodide.

THE SYSTEM CESIUM IODIDE - IODINE - WATER--Contd.

t°	Gms. per 100 gms. sat. sol.		Solid Phase
	I	CsI	
- 0.2	0.34	0.88	Ice + I ₂ + CsI ₄
- 0.3	0.42	1.46	Ice + CsI ₄
- 0.4	0.38	2.63	"
- 0.5	0.31	3.47	Ice + CsI ₄ + CsI ₃
- 0.8	0.21	5.30	Ice + CsI ₃
- 2.2	0.08	15.07	"
- 2.5	0.07	19.26	"
- 3.2	0.05	23.60	"
- 4.0	0.06	27.78	Ice + CsI + CsI ₃
3.8	0.09	33.51	CsI + CsI ₃
12.0	0.16	39.39	"
20.0	0.29	44.14	"
25.0	0.38	46.4	"
34.6	0.64	51.23	"
48.5	1.22	56.52	"
60.8	2.05	60.41	"
7.2	0.44	4.34	CsI ₃ + CsI ₄
9.0	0.54	4.51	"
25.0	1.19	7.65	"
25.4	1.34	7.54	"
44.1	2.93	13.03	"
54.8	5.44	18.14	"
57.8	5.85	18.97	"
62.0	8.54	22.31	"
69.4	12.52	26.15	"
71.9	15.41	29.44	"
71.1	3.06	62.66	CsI + CsI ₃
80.1	4.62	64.90	"
85.0	5.69	65.07	"
90.0	7.19	65.43	"
100.1	12.16	64.76	"
105.4	16.23	63.40	"
75.1	18.33	30.84	CsI ₃ + CsI ₄
76.0	19.12	31.51	"
77.8	23.95	33.53	"
79.3	29.68	35.69	"
79.6	34.67	37.14	"
80.1	36.65	37.93	"
80.4	40.04	38.41	"
80.6	44.42	38.43	"
81.0	48.48	38.88	"
82.2	51.70	38.61	"
84.5	53.87	38.66	"
88.0	56.28	38.14	"
95.2	59.10	37.39	"
103.3	61.36	36.26	"
6.4	0.75	1.93	CsI ₄ + I ₂
25.0	1.23	2.39	"
27.6	1.57	3.24	"
36.4	2.24	4.28	"
48.0	3.39	6.06	"

(Cont.)

Cs CESIUM

THE SYSTEM CESIUM IODIDE - IODINE - WATER--Contd.

Gms. per 100 gms. sat. sol.

t°	I	CsI	Solid Phase
51.5	4.09	6.93	CsI ₄ + I ₂ (+ 2 liquids)
51.5	74.33	23.24	"
60.6	77.50	21.07	CsI ₄ + I
54.6	4.55	7.78	CsI ₄ (+ 2 liquids)
65.0	7.69	12.36	"
67.3	8.93	13.87	"
70.9	10.01	16.37	"
72.3	11.80	18.09	"
74.4	13.90	20.71	"
74.9	14.78	21.25	"
76.7	17.31	24.16	"
78.2	19.16	26.38	"
79.5	24.34	31.27	"
80.0	26.49	32.61	"
80.4	28.50	34.31	"
80.6	38.22	36.92	"
80.6	48.18	37.98	"
80.0	52.85	37.27	"
79.5	53.60	37.22	"
79.4	55.77	36.28	"
77.0	59.47	34.01	"
73.9	64.48	31.23	"
67.0	68.17	28.12	"
56.4	72.90	24.64	"
74.1	4.15	6.08	I ₂ (+ 2 liquids)
80.8	4.35	5.83	"
89.6	4.18	5.48	"
93.4	4.55	5.42	"
74.1	79.71	18.98	"
81.0	82.02	16.18	"
86.0	84.05	14.57	"
*98.2	3.84	4.58	"
*98.2	87.84	10.77	"
*100.6	24.97	21.03	(2 liquids)
*100.6	59.50	28.81	"
*109.3	9.76	66.30	CsI
*109.7	20.8	61.9	CsI + CsI ₃
*108.9	24.57	57.83	CsI ₃
*108.3	26.13	56.24	"
*108.1	26.55	55.64	"
*107.5	28.83	53.83	"
*107.0	35.38	49.85	"
*106.7	38.24	49.28	"
*106.2	42.42	46.42	"
*106.5	47.65	45.73	"
*122	51.00	46.93	"

*Boiling point

(Cont.)

OLDER DATA IN THE SYSTEM CsI - I - H₂O
Results at 25°
(Briggs and Greenawald, 1930)

Particular attention was paid in these experiments to securing equilibrium. The mixtures were given a preliminary heating to 95° and were also constantly rotated for many weeks. The attainment of equilibrium was especially difficult in the mixtures giving the higher of the two polyiodides as solid phase.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
CsI	free I	Solid Phase	CsI	free I	Solid Phase	CsI	free I	Solid Phase
46.1	0.0	CsI	12.1	0.87	CsI ₃	4.33	1.16	CsI ₄
46.4	0.31	"	10.0	0.98	"	4.13	1.25	"
46.4	0.40	" + CsI ₃	8.15	1.13	"	3.42	1.27	"
43.3	0.41	CsI ₃	7.60	1.18	"	3.04	1.22	"
40.9	0.42	"	7.65	1.19	" + CsI ₄	2.94	1.19	"
34.5	0.43	"	7.16	1.23	CsI ₄	2.87	-	"
29.4	0.50	"	6.36	1.16	"	2.47	-	"
27.1	0.53	"	6.04	1.22	"	2.39	1.23	" + I
24.4	0.56	"	5.67	1.22	"	2.10	1.20	I
17.7	0.66	"	4.76	1.22	"	1.27	0.62	"
15.2	0.69	"	4.52	1.24	"	0.89	0.52	"

Results of Foote, 1903

Gms. per 100 Gms. Solution			Gms. per 100 Gms. Solution			Solid Phase at both Temps.
t°	CsI	I	t°	CsI	I	
-4	27.68	0.0	35.6	51.48	0.0	CsI
-4	27.52	0.09	35.6	51.66	0.71	CsI and CsI ₃
-4	3.18	0.31	35.6	10.72	1.78	CsI ₃ and CsI ₃
-0.2	0.85	0.34	35.6	3.74	1.60	CsI ₃ and I

In Separated Heavy Solution

Gms. per 100 Gms. Solution			Gms. per 100 Gms. Solution			Solid Phase
t°	CsI	I	t°	CsI	I	
52.2	16.75	4.52	...	...	...	CsI ₃ and CsI ₃
52.2	6.69	3.36	...	...	...	CsI ₃ and I
52.2	6.72	3.32	22.94	73.72	...	CsI ₃
52.2	6.65	3.45	22.80	74.63	...	I
73	26.98	15.07	...	...	...	CsI ₃ and CsI ₃
73	16.66	10.50	27.56	68.40	...	CsI ₃
73	6.27	4.08	17.68	80.02	...	I

(Cont.)

Ca CESIUM

Results of Foote and Chalker, 1908 at 25°

Gms. per 100 Gms. Sat. Solution		Empirical Comp. of Residue	Present in Residue
CsI	I		
7.72	1.18	CsI _{3.29}	CsI ₃ and CsI ₅
7.69	1.19	CsI _{3.98}	" "
2.40	1.23	CsI _{5.75}	CsI ₅ and I
2.35	1.23	CsI _{7.43}	" "
2.39	1.25	CsI _{19.3}	" "

EQUILIBRIUM IN THE SYSTEM CESIUM IODIDE - MERCURIC IODIDE - WATER (Pernot, 1936, 1938)

Results for the isotherms 0°, 12°, 34°, 54° and 78° are shown in the form of diagrams but numerical data are not given in the present papers. Five cesium iodo mercurates were identified. Three, namely, 2CsI·3HgI₂, 2CsI·HgI₂ and 3CsI·HgI₂ exist at all the temperatures. CsI·HgI₂ exists from 0° to 12°, and CsI·HgI₂, exists at temperatures above 54°.

100 gms. sat. solution of cesium Iodide in Liquid Ammonia contain 60.28 gms. CsI at 0°. (Linhard and Stephan, 1933, 1934)

EQUILIBRIUM IN THE SYSTEM CESIUM IODIDE - IODINE - BENZENE (Foote, Bradley and Fleischer, 1933)

Results at 6°		Results at 25°	
Gms. I per 100 gms. sat. sol.	Solid Phase	Gms. I per 100 gms. sat. sol.	Solid Phase
0.023	CsI + CsI ₃	0.047	CsI + CsI ₃
0.55	CsI ₃	0.77	CsI ₃
1.20	"	1.34	"
1.30	" + CsI ₄	2.35	" + CsI ₄
2.00	CsI ₄	3.89	CsI ₄
3.41	"	5.27	"
3.80	" + T.C.	7.75	" + T.C.
4.55	T.C.	8.88	T.C.
6.25	"	12.19	"
6.60	"	13.96	" + I ₂
8.59	" + I ₂		

T.C. = Ternary compound of the probable composition 2CsI·9I₂·4C₆H₆.

EQUILIBRIUM IN THE SYSTEM CESIUM IODIDE - IODINE - TOLUENE
(Foote, Bradley and Fleischer, 1933)

Results at 6°		Results at 25°	
Gms. I per 100 gms. sat. sol.	Solid Phase	Gms. I per 100 gms. sat. sol.	Solid Phase
0.024	CsI + CsI ₃	0.053	CsI + CsI ₃
0.54	CsI ₃	0.77	CsI ₃
1.08	"	1.72	"
1.53	" + CsI ₄	2.54	" + CsI ₄
4.35	CsI ₄	3.09	CsI ₄
6.74	"	9.90	"
10.41	" + I ₂	14.60	"
		15.41	" + I ₂

Since cesium iodide is insoluble in benzene and in toluene none was found in the above saturated solutions.

SOLUBILITY OF CESIUM IODIDE IN ACETONE
(Evertz and Livingston, 1949)

Temp.	Gms. CsI per 100 gms. Sat. Sol.	Temp.	Gms. CsI per 100 gms. Sat. Sol.
-78.5°	0.36	18°	0.159*
-60°	.38	20°	.22
-40°	.37	25°	.20
-20°	.35	30°	.18
0°	.29	37°	.139*
		40°	.13

*Lannung, 1932 $d_{18}^{\circ} = 0.796$, $d_{37}^{\circ} = 0.771$

SOLUBILITY OF CsI IN SEVERAL ORGANIC SOLVENTS
(Pavlopoulos and Strehlow, 1954)

Solvent	t°	Gms. CsI per 100 gms. solvent	density sat. sol.
Methanol	18	3.05	0.815
	25	3.79	0.813
Acetonitrile	18	0.76	0.789
	25	0.99	0.787
Formic Acid	18	28.1	1.456
	25	29.5	1.469

Cs CESIUM

EQUILIBRIUM IN THE SYSTEM CESIUM IODIDE - IODINE
(Briggs, 1930)

t°	Mol. Per cent CsI	Solid Phase	t°	Mol. Per cent CsI	Solid Phase	t° (b.pt.)	Mol. Per cent CsI
113	0.0	I	134	30.	CsI ₄	183	0
108	5.0	"	149	32.5	CsI ₃	188	10
100	9.0	"	171	36.5	"	197	20
88	13.0	"	175	37.5	"	212	30
71 (Eut.)	18.0	" + CsI ₄	186	40.0	"	247	40
92	22.5	CsI ₄	199	43.0	"	302	50
110	25.0	"	211	48.0	" + CsI	304	70
122	27.5	"	211	70.0	CsI ₃	303	90
			303	49.4	CsI		

EQUILIBRIUM IN THE SYSTEM CESIUM IODIDE - SULFUR DIOXIDE
(Foote and Fleischer, 1931)

The system was studied by means of the vapor pressure temperature relations.

The following data were obtained for the two univariant systems:

CsI·3SO₂ + Solution + VaporCsI·3SO₂ + CsI + Vapor

t°	Pressure Gm. Hg	t°	Pressure Gm. Hg
-21.60	42.7	-19.60	6.3
-18.45	48.8	-10.90	12.3
-16.30	53.9	- 5.25	18.4
-11.5	65.8	0.0	26.65
- 8.10	75.5	+ 7.5	43.8
- 4.25	87.1	12.40	60.3
- 0.0	102.5	20.25	98.2

The increasing solubility of the compound CsI·3SO₂ in liquid sulfur dioxide with rising temperature causes the vapor pressure curve of the saturated solution to diverge considerably from that of pure SO₂. At somewhat higher temperatures the curves of the two univariant systems probably intersect.

Link and Wood (1940) studied the reaction, below the melting points, for the following salt pairs:

CsI + LiF
CsI + KFCsI + NaF
CsI + LiBrCsI + LiCl
CsI + RbF

CESIUM Dichloro IODIDE CsCl_2I SOLUBILITY IN AQUEOUS HYDROCHLORIC ACID SOLUTIONS
(Bender and Strehlow, 1948)

Solvent: Gm. mols. HCl per 1000 gms. H_2O	Results at 0°		Results at 25°	
	Gms. CsCl_2I per 100 gms. Solution	Gms. CsCl_2I per 100 cc Solution	Gms. CsCl_2I per 100 gms. Solution	Gms. CsCl_2I per 100 cc Solution
0.8805	3.623	3.783	9.059	9.805
1.998	3.524	3.745	8.274	9.052
2.989	3.321	3.577	7.470	8.236
4.909	2.890	3.187	6.097	6.824
6.987	2.553	2.877	5.057	5.746
8.989	2.343	2.691	4.455	5.142
10.75	2.231	2.604	4.139	4.841
12.48	2.189	2.591	3.964	4.697
15.29	2.195	2.652	3.894	4.700

CESIUM IODATE CsIO_3

10

100 parts H_2O dissolve 2.6 parts CsIO_3 at 24°, and 2.5 parts $2\text{CsIO}_3 \cdot \text{I}_2\text{O}_5$ at 21°. (Wheeler, 1892; Barker, 1908)

CESIUM PERIODATE CsIO_4

100 gms. H_2O dissolve 2.15 gms. CsIO_4 at 15°, d_{15}^4 sat. solution = 1.0166. (Barker, 1908)

CESIUM PERMANGANATE CsMnO_4

MnO

SOLUBILITY IN WATER

t°	Gms. CsMnO_4 per 100 cc sat. sol.	Author
1	0.097	(Patterson, 1906)
19	0.23	(" ")
20	0.23	(Treadwell and Ammann, 1938)
59	1.25	(Patterson, 1906)

Cs CESIUM

MoO CESIUM MOLYBDATE Cs_2MoO_4

SOLUBILITY IN WATER AT 18°

100 gms. of a saturated solution contains 67.07 gms. Cs_2MoO_4 (4.8 moles per liter). (Spitsyn and Kuleshov, 1951)

Melting point data are given for the system $Cs_2MoO_4 - MoO_3$ by Spitsyn and Kuleshov, 1951a.

N CESIUM AZIDE CsN_3

100 gms. sat. solution of Cesium Azide in water contain 69.16 gms. CsN_3 at 0° and 75.45 gms. at 16°. (Curtius and Rissom, 1898)

NO CESIUM NITRATE $CsNO_3$

SOLUBILITY IN WATER (Berkeley, 1904; Ice curve by Jones, 1908)

t°	Gms. $CsNO_3$ per 100 Gms.		G. Mols. $CsNO_3$ per Liter
	Solution	Water	
- 0.3	-	0.21	Solid Phase ICE
- 0.4	-	1.28	
- 1.2	-	6.01	
- 1.3	-	8.0	
- 1.4	-	-	
(-1.254)		(8.51) ¹	ICE + $CsNO_3$
0	8.54	9.33	0.476
5	10.44 ²	-	-
10	12.97	14.9	0.725
20	18.7	23.0	1.11
25	21.53 ³	-	-
30	25.3	33.9	1.58
40	32.1	47.2	2.12
50	39.2	64.4	2.73
60	45.6	83.8	3.41
70	51.7	107.0	4.10
80	57.3	134.0	4.81
90	62.0	163.0	5.50
100	66.3	197.0	6.19
106.2	68.8	220.3	6.58

¹Washburn and MacInnes, 1911

²Noonan, 1948

³Malquori, 1928d

SOLUBILITY OF CsNO_3 in D_2O

100 gms. of a saturated solution in water containing 91.43% D_2O contains 8.17 gms. CsNO_3 at 5° (Noonan, 1948).

NO

EQUILIBRIUM IN THE SYSTEM CESIUM NITRATE - LEAD NITRATE - WATER AT 25°
(Malquori, 1928d)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CsNO_3	$\text{Pb}(\text{NO}_3)_2$		CsNO_3	$\text{Pb}(\text{NO}_3)_2$	
21.53	0.0	CsNO_3	14.09	38.13	CsNO_3
19.88	4.37	"	12.84	42.10	" + $\text{Pb}(\text{NO}_3)_2$
18.21	10.79	"	7.97	40.22	$\text{Pb}(\text{NO}_3)_2$
17.65	18.43	"	4.49	39.32	"
17.08	29.30	"	2.14	38.30	"
15.23	34.65	"	0.0	37.07	"

Melting point data are given for:

$\text{CsNO}_3 + \text{LiNO}_3$	(Fuschin and Radoicic, 1937)
$\text{CsNO}_3 + \text{Pb}(\text{NO}_3)_2$	(" " " ")
$\text{CsNO}_3 + \text{TiNO}_3$	(Protzenko and Rubleva, 1955)
$\text{CsNO}_3 + \text{HbNO}_3$	(Blidin, 1953)
$\text{CsNO}_3 + \text{N}_2\text{H}_5\text{NO}_3$	(Barlot and Marsaule, 1948)

CESIUM NIOBATE CsNbO_3

NbO

SOLUBILITY IN WATER
(Lapitskii, Shishkina, Pchelkina and Stepanov, 1955)

t°	0	25	50	75	100
[Mg. CsNbO_3 per 100 ml.	2.40	2.45	4.23	6.22	7.74
[Moles CsNbO_3 per liter	0.000086	0.000087	0.00015	0.00023	0.00028

CESIUM HYDROXIDE CsOH

OH

SOLUBILITY OF CESIUM HYDROXIDE IN WATER

t°	Gms. CsOH per 100 gms. sat. sol.	Authority
15	79.41	(de Forcrand; 1909a)
30	75.18	(Schreinemakers and Meijeringh, 1908)

Cs CESIUM

ReO CESIUM PERRHENATE CsReO_4

SOLUBILITY IN WATER

(Smith and Long, 1948; Noddack and Noddack, 1931)

t°	Gms. CsReO_4 per 1000 gms. H_2O
0	3.83
19	7.8 (N.&N.-gms. per 1000 cc H_2O)
30	11.00
50.3	24.52

Data for the distribution of cesium perrhenate between nitromethane and water at 25° are given by Friedman and Haugen, 1954.

S CESIUM SULFIDES Cs_2S , Cs_2S_5

Fusion-point data for mixtures of Cs_2S + Cs_2S_5 and for Cs_2S_5 + S are given by Biltz and Wilke-Dorfurt, 1906.

SO CESIUM FLUOSULFATE CsSO_3F

100 cc sat. solution of Cesium Fluosulfate in water contain 2.23 gm. CsFSO_3 at 0°. (Lange, 1927)

SO CESIUM SULFATE Cs_2SO_4

SOLUBILITY IN WATER

(Berkeley, 1904)

t°	Gms. Cs_2SO_4 per 100 Gms.		G. Mols. Cs_2SO_4 per Liter	t°	Gms. Cs_2SO_4 per 100 Gms.		G. Mols. Cs_2SO_4 per Liter
	Solution	Water			Solution	Water	
0	62.6	167.1	3.42	60	66.7	199.9	3.78
10	63.4	173.1	3.49	70	67.2	205.0	3.83
20	64.1	178.7	3.56	80	67.8	210.3	3.88
25	64.54*	-	-	90	68.3	214.9	3.92
30	64.8	184.1	3.62	100	68.8	220.3	3.97
40	65.5	189.9	3.68	108.6	69.2	224.5	4.00
50	66.1	194.9	3.73				

*Calvo and Simons, 1952 (d. = 2.005)

FREEZING POINTS IN THE SYSTEM Conc H_2SO_4 - Cs_2SO_4
(Gillespie and Oubridge, 1956)

H_2SO_4 of maximum freezing point was used.

Moles Cs_2SO_4 per 1000 gms. H_2SO_4	0.0	0.02	0.05	0.10
Freezing point of the solution	10.368°	9.995°	9.286°	8.060°

THE SYSTEM CESIUM SULFATE - AMMONIUM SULFATE - WATER AT 25°
(Calvo and Simóns, 1952)

Continuous solid solutions of Roozeboom Type II are formed.

80

Gms. per 100 gms. sat. sol.		Density	Wt. % $(\text{NH}_4)_2\text{SO}_4$ in solid phase
$(\text{NH}_4)_2\text{SO}_4$	Cs_2SO_4		
43.41	19.0	1.226	100.0
40.08	6.49	1.281	99.0
36.22	13.70	1.355	96.2
31.69	22.03	1.443	92.7
28.01	29.20	-	85.6
23.61	37.31	1.620	76.7
21.32	41.75	1.688	67.4
21.36	41.74	1.688	66.7
18.71	46.01	1.727	48.3
18.25	47.01	1.773	40.5
18.13	47.08	-	37.1
17.24	48.10	1.790	30.8
15.38	50.30	1.808	14.5
12.16	53.44	1.853	8.4
8.16	57.23	1.909	3.7
0.0	64.54	2.005	0.0

THE SYSTEM CESIUM SULFATE - PRASEODYMIUM SULFATE - WATER AT 25°
(Restanió, 1934)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Cs_2SO_4	$\text{Pr}_2(\text{SO}_4)_3$	Solid Phase	Cs_2SO_4	$\text{Pr}_2(\text{SO}_4)_3$	Solid Phase
41.62	-		0.40	0.10	
20.15	-	1.1.8	0.35	7.00	"
16.06	-	"	0.31	8.16	-
7.21	-	"	0.33	8.21	-
1.92	0.47	"	0.15	8.39	-
0.45	3.70	"			

1.1.8 = $\text{Cs}_2\text{SO}_4 \cdot \text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$.

Cs CESIUM

50 CESIUM ALUMS $\text{CsM}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$

SOLUBILITIES IN WATER (Locke, 1901)

Formula of Alum	t°	Gms. per 100 cc H ₂ O		Gram Mols. $\text{CaM}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ per 100 cc H ₂ O
		Anhydrous Salt	Hydrated Salt	
$\text{CsCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25	0.57	0.94	0.00151
"	30	0.96	1.52	0.0025
"	35	1.206	1.91	0.0032
"	40	1.53	2.43	0.00405
$\text{CsFe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25	1.71	2.72	0.0045
"	30	2.52	4.01	0.0066
"	35	3.75	6.01	0.0099
"	40	6.04	9.80	0.0156
$\text{CsIn}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25	7.57	11.73	0.0172
$\text{CsV}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25	0.771	1.31	0.00204
$\text{CsGa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25	-	1.51(g. per 100 cc sat. sol.)	

(Dennis and Bridgeman, 1918)

SOLUBILITIES IN SOLUTIONS CONTAINING ETHANOL AT 25° (Dennis and Bridgeman, 1918)

Constant agitation is not mentioned. The analyses are reported in terms of gms. of Ga_2O_3 per 100 gms. of saturated solution and the corresponding gms. of alum are calculated to 100 cc of sat. solution, but the density determinations required for this are not given.

Formula	Solvent	Gms. Ga_2O_3 per 100 gms. sat. sol.	Gms. Alum per 100 cc sat. sol.
$\text{CsGa}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	50% alcohol	0.00059	0.00387
"	70% "	0.00054	0.00356
"	Aq. mixture *	0.0035	0.0228

*Composed of 35 cc H₂O, 50 cc C₂H₅OH and 15 cc conc. H₂SO₄.

50 CESIUM DOUBLE SULFATES $\text{Cs}_2\text{M}(\text{SO}_4)_2$

SOLUBILITY OF CESIUM DOUBLE SULPHATES IN WATER AT 25° (Locke, 1902)

Name	Formula	Gms. Anhydrous Salt per 100 Gms.		Gm. Mols. Salt per 100 Gms. H ₂ O
		Solution	Water	
Cesium Cadmium Sulphate	$\text{Cs}_2\text{Cd}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	58.16	139.9	0.2455
Cesium Cobalt Sulphate	$\text{Cs}_2\text{Co}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	29.52	41.9	0.081
Cesium Copper Sulphate	$\text{Cs}_2\text{Cu}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	31.49	46.0	0.0882
Cesium Iron Sulphate	$\text{Cs}_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	50.29	101.1	0.1967
Cesium Magnesium Sulphate	$\text{Cs}_2\text{Mg}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	34.77	53.3	0.1106
Cesium Manganese Sulphate	$\text{Cs}_2\text{Mn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	44.58	80.4	0.157
Cesium Nickel Sulphate	$\text{Cs}_2\text{Ni}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	20.37	25.6	0.0495
Cesium Zinc Sulphate	$\text{Cs}_2\text{Zn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	27.87	38.6	0.0738

SOLUBILITY OF CESIUM SODIUM SULFATES IN WATER AT 25°
(Foote, 1911)

30

Gms. per 100 Gms. Sat. Solution		Per cent CaSO_4 in Residue	Empirical Composition of Residue
Cs_2SO_4	Na_2SO_4		
54.65	11.44	89.98	$1\text{Na}_2\text{SO}_4 \cdot 3.53\text{Ca}_2\text{SO}_4$
54.58	11.63	78.22	$1\text{Na}_2\text{SO}_4 \cdot 1.41\text{Ca}_2\text{SO}_4$
54.81	11.25	34.67	$4.8\text{Na}_2\text{SO}_4 \cdot 1\text{Cs}_2\text{SO}_4$

Melting point data are given for:

$\text{Cs}_2\text{SO}_4 + \text{KCl}$	} Dombrovskaya, 1933
" + K_2SO_4	
" + Li_2SO_4	
	Dergunov, 1951

CESIUM DISULFITE $\text{Cs}_2\text{S}_2\text{O}_5$

100 gms. liquid Sulfur Dioxide dissolve 0.047 gm. $\text{Cs}_2\text{S}_2\text{O}_5$ at 0°. (Jander and Wickert, 1936.)

CESIUM SELENATE Cs_2SeO_4

SeO

100 grams H_2O dissolve 245 grams Cs_2SeO_4 at 12°. (Tutton, 1897)

CESIUM GALLIUM SELENATE ALUM

100 cc of a saturated solution in water at 25° contain 4.15 gms. $\text{CsGa}(\text{SeO}_4)_2 \cdot 12\text{H}_2\text{O}$. (0.53 gms. Ga_2O_3 per 100 gms. sat. sol.) (Dennis and Bridgeman, 1918)

CESIUM TANTALATE CsTaO_3

TaO

SOLUBILITY IN WATER
(Lapitskii, Stepanov and Pehelkina, 1955)

t°	0	25	50	75	100
{ Mg. CsTaO_3 per 100 ml.	1.01	1.12	1.63	4.11	4.75
{ Moles CsTaO_3 per liter	0.0000283	0.0000308	0.0000449	0.000113	0.000475

CESIUM TUNGSTATE Cs_2WO_4

WO

At 17° a saturated solution in water contains 85.6 wt. % Cs_2WO_4 . (Spitsyn, 1947)

COPPER Cu

SOLUBILITY IN WATER
(Pariaud and Archinard, 1952)

The water was thoroughly degassed and free of dissolved substances. The metal was electrolytically pure, polished, degassed and pulverized. The solution was neutral. After six days at 30°, analysis with dithizone showed a solubility of 166 γ per liter. A second sample showed 177 γ after 29 days.

SOLUBILITY OF COPPER IN MILK
(Quam, 1929)

Highly polished 4 x 7.5 cm. strips of Copper were immersed in 50 cc portions of raw milk and rocked 46 times per minute for 30 minutes. The loss in weight of the copper strips was determined by difference and the results expressed as milligrams Cu dissolved per sq. decimeter of surface. The dissolved copper was also determined by analysis of the milk after the period of contact with the metal.

t°	Mgs. Cu dissolved per sq. decimeter	t°	Mgs. Cu dissolved per sq. decimeter	t°	Mgs. Cu dissolved per sq. decimeter
30	0.258	60	1.118	85	1.892
40	0.516	65	1.333	90	1.961
45	0.671	70	1.462	95	1.788
50	0.860	80	1.806	100	1.376

Data for the rate of solution of copper in potassium cyanide solutions are given by Plaksin and Shibaev, 1936. The rate was also determined as a function of the composition of alloys of Cu + Ag and Cu + Au.

SOLUBILITY OF COPPER IN MERCURY
(Irvin and Russell, 1932)

Copper amalgam was prepared by three methods and the samples passed through sintered glass filters until a thick layer of paste was formed. The filtrate was then passed twice through its paste and analyzed. When chamois leather was used instead of sintered glass irregular and higher results were obtained. The average of a large number of determinations was 0.0020 gm. Cu per 100 gms. Hg at 20°.

Previous determinations by Tammann, Kollmann and Hinuber, 1927, made by the electrometric method, gave 0.0032 gm. Cu per 100 gms. Hg at 18°.

Data for the system copper - gallium (30-100 at % Ga) are given by Betterton and Hume-Rothery, 1952.

The following systems have been studied:

Cu + P	Maltsev (1939)
Cu + Ni + S	Köster and Mulfinger (1940)
Cu + CuSO ₄ + Se	Goria (1940)
Cu + S	Klochko and Mironova, 1954
Cu + Cu ₂ S	{ Chizhikov, Gulyanitskaya and Bogovarova, 1955; Esin and Sryvalin, 1951.
Cu + Cu ₂ O	Gebhardt and Obrowski, 1954
Cu + Fe ₂ P + Cu ₃ P + Fe	Vogel and Horstman, 1953
Cu + FeSi + Cu ₃ Si + Fe	Vogel and Berek, 1950

The distribution of Cu in the system Sn + SnS has been studied at 910° by Anderson and Ridge (1943). The Cu is concentrated preferentially in the sulfide phase.

Data for the distribution of Copper between, Zinc and Lead, Zinc and Bismuth, Aluminum and Lead and Aluminum and Bismuth are given by Tammann and Schaftmeister, 1924.

COPPER ARSENATES $\text{CuO} \cdot y\text{As}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

AsO

THE SYSTEM $\text{CuO} + \text{As}_2\text{O}_5 + \text{H}_2\text{O}$ (Mas, 1949)

Gms. per 100 gms. sat. sol.

As ₂ O ₅	CuO	Solid Phase
0.180	0.0045	4CuO·As ₂ O ₅ ·H ₂ O
0.340	.083	"
0.490	.120	"
0.660	.141	"
0.840	.180	"
0.89	.175	"
0.990	.210	"
1.048	.206	"
1.055	.220	" + 3CuO·As ₂ O ₅ ·4H ₂ O
1.070	.227	3CuO·As ₂ O ₅ ·4H ₂ O
1.120	.230	"
0.110	.032	5CuO·2As ₂ O ₅ ·10H ₂ O
0.240	.051	"
0.360	.084	"
0.440	.102	"
0.750	.172	" + 2CuO·As ₂ O ₅ ·3H ₂ O
0.700	.153	" + "
0.540	.120	" + "
0.420	.095	2CuO·As ₂ O ₅ ·3H ₂ O
0.700	.140	"
0.950	.210	"
1.120	.240	"
3.52	.56 ^a	"
6.35	.79 ^b	"
10.42	1.12 ^c	"

^ad. = 1.03

^bd. = 1.06

^cd. = 1.10

Cu CUPRUM

THE SYSTEM $\text{CuO} + \text{As}_2\text{O}_3 + \text{H}_2\text{O}$ --Contd.

Gms. per 100 gms. sat. sol.		Density	Solid Phase
As_2O_3	CuO		
44.29	1.40	1.14	$2\text{CuO} \cdot \text{As}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$
28.40	1.51	1.34	"
34.45	1.76	1.46	"
40.25	2.00	1.53	"
50.00	2.78	1.74	"
59.45	2.95	1.95	"
60.25	3.18	1.95	"
61.10	2.80	1.95	" + $\text{CuO} \cdot 2\text{As}_2\text{O}_3 \cdot 7\text{H}_2\text{O}$
61.87	2.00	1.95	$\text{CuO} \cdot 2\text{As}_2\text{O}_3 \cdot 7\text{H}_2\text{O}$
62.25	1.80	1.97	"
62.25	1.50	1.96	"
64.50	1.30	1.97	"
64.80	1.04	1.96	"
65.10	0.81	2.00	" + $\text{CuO} \cdot 2\text{As}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
66.25	0.50	2.03	$\text{CuO} \cdot 2\text{As}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
67.50	0.35	2.06	"
68.00	0.40	2.04	"
68.50	0.30	2.05	"
69.00	0.25	2.09	"
71.45	-	2.15	" + As_2O_3

AsO COPPER ARSENITES and ARSENATES

Data for the solubility of various copper arsenites and arsenates in dilute ammonia and acetic acid solutions at 25° and 70° are given by Kuperman, Orlov, Krutitshaya and Trushkina, 1955.

Br CUPROUS BROMIDE CuBr

SOLUBILITY IN WATER (Gavrish and Galinker, 1955)

The authors tables are headed "moles per 100 gms. H_2O ," but reasoning from their data on the silver halides, it is probable that moles per 1000 gms. of H_2O is meant.

t°	Moles CuBr per 1000 gms. H_2O	t°	Moles CuBr per 1000 gms. H_2O	t°	Moles CuBr per 1000 gms. H_2O
200	0.0149	260	0.049	300	0.0820
220	.0217	270	.066	310	.0930
230	.0286	280	.0716	320	.101
240	.0369	290	.0790	330	.107
250	.0411				

SOLUBILITY OF CUPROUS BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM
BROMIDE AT 18°-20°

(Bodlander and Storbeck, 1902)

Millimols per Liter					Grams per Liter			
KBr	Total Cu	Total Br	Cu(ic)	Cu(ous)	KBr	Total Cu	Cu(ic)	Cu(ous)
0	0.3157	0.4320	0.2096	0.1061	0	0.0201	0.0133	0.0067
25	0.119	...	0.012	0.107	2.98	0.0076	0.0007	0.0068
40	0.200	...	0.013	0.187	4.76	0.0127	0.0007	0.0119
60	0.310	...	0.025	0.285	7.15	0.0197	0.0015	0.0181
80	0.423	...	0.012	0.411	9.53	0.0266	0.0007	0.0261
100	0.584	...	...	0.584	11.91	0.0371	...	0.0371
120	0.693	...	...	0.693	14.29	0.0441	...	0.0441
500	8.719	...	...	8.719	59.55	0.5540	...	0.5540

100 gms. acetonitrile dissolve 3.86 gms. CuBr at 18°. (Naumann and Schier, 1914)

CUPROUS Tetrapyrindine BROMIDE $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2$

Br

SOLUBILITY IN WATER

(Marukhyan, 1940)

t°	Gms. $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2$ per 100 ml. H_2O	t°	Gms. $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2$ per 100 ml. H_2O
25	0.25	50	0.36
30	.30	55	.41
35	.32	60	.423
40	.34	65	.45
45	.345	70	.49

SOLUBILITY OF $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2 + [\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Cl}_2$ IN WATER
(Marukhyan, 1940)

t°	Gms. $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2 + [\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Cl}_2$ per 100 ml. H_2O	t°	Gms. $[\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Br}_2 + [\text{Cu}_2(\text{C}_5\text{H}_5\text{N})_4]\text{Cl}_2$ per 100 ml. H_2O
25	0.43	50	0.683
30	.50	55	.711
35	.61	60	.75
40	.64	65	.82
45	.65	70	.87

Freezing-point lowering data for mixture of CuBr + KBr are given by de Cesaris, 1911.

Cu CUPRUM

Br CUPRIC BROMIDE CuBr_2

SOLUBILITY IN WATER
(Carter and Megson, 1928)

t°	Gms. per 100 gms. sat. sol.	Solid Phase	t°	Gms. per 100 gms. sat. sol.	Solid Phase
0.0	51.8	$\text{CuBr}_2 \cdot 4\text{H}_2\text{O}$	20	55.9	CuBr_2
5.75	52.8	"	25	55.8	"
9.9	53.7	"	30.1	56.1	"
15.0	55.0	"	34.8	56.0	"
18.0 (Tr.pt.)	55.9	" + CuBr_2	50.0	56.8	"
0.0	55.7	CuBr_2 (Metastable)			

Below the transition point the solid phase consists of green needles and above of black rhomboids. The d_{25}^{25} of the sat. solution at 25° is 1.84.

SOLUBILITY OF CuBr_2 IN HYDROCHLORIC ACID SOLUTIONS AT 25°
(Carter and Megson, 1928)

d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.		d_{25}^{25} of sat. sol.	Gms. per 100 gms. sat. sol.	
	CuBr_2	HBr		CuBr_2	HBr		CuBr_2	HBr
1.84	55.8	0.0	1.63	26.9	26.0	-	18.5	43.6
1.82	52.3	2.9	1.64	25.9	26.9	1.79	15.8	48.0
1.78	48.3	6.3	1.65	23.1	31.9	-	15.1	48.8
1.73	43.2	10.6	1.68	22.2	34.6	-	11.8	53.5
1.69	37.6	25.4	1.72	20.4	39.1	-	10.8	54.7
1.65	32.9	19.4	1.74	19.2	42.1	1.83	7.7	59.3

The solid phase is the anhydrous CuBr_2 (black rhomboids) throughout. Data are also given for equilibrium at 0° and for the metastable portion of the curve at 25°.

SOLUBILITY OF CuBr_2 IN ORGANIC SOLVENTS

100 gms. acetonitrile dissolve 24.43 gms. CuBr_2 at 18°. (Naumann and Schlier, 1914)

100 gms. 95% formic acid dissolve 0.16 gm. CuBr_2 at 21°. (Aschan, 1913)

Heines and Yntema, 1938 allowed 5 gms. of solid to stand in contact with 25 cc of anhydrous dioxane for two weeks at 26.5°, and found the solubility to be 0.075 gms. per 100 cc of saturated solution.

COPPER(ous) ACETYLIOE Cu_2C_2

C

The "hydrolytic solubility product" $L = [\text{Cu}^+]^2[\text{C}_2\text{H}_2][\text{OH}^-]^2$ was determined by Babko and Grebel'skaya, 1952 as follows:

Solvent	L	Solvent	L
0.1M HNO_3	1.2×10^{-37}	0.1M H_2SO_4	1.2×10^{-37}
.01M HNO_3	6.7×10^{-36}	0.1M H_2SO_4	2.8×10^{-36}
.1M HClO_4	1.2×10^{-37}	Acetic acid:	
.01M HClO_4	6.7×10^{-36}	$\text{H}^+ = .0042$	3.8×10^{-34}
Results in HCl indicate a value of		$\text{H}^+ = .0013$	1.2×10^{-33}
L about 30 times as large as in HNO_3 .			

COPPER METHIONATE $\text{CuCH}_2\text{O}_6\text{S}_2$

CH

100 gms. Water dissolve 76.8 gms. $\text{CuCH}_2\text{O}_6\text{S}_2$ at 25° . (Backer and Terpstra, 1929)

COPPER FORMATE $\text{Cu}(\text{CHO}_2)_2$

CH

SOLUBILITY OF CUPRIC FORMATE IN FORMIC ACID
(Davidson and Holm, 1931)

t°	25°	35°	42°	49°	52°
Mols. $\text{Cu}(\text{CHO}_2)_2$ per 100					
Mols. $\text{Cu}(\text{CHO}_2)_2 + \text{HCOOH}$	0.004	0.0045	0.0048	0.0065	0.0075

The determinations were made by the freezing-point method. The bright blue solid phase could not be obtained in sufficient quantity for analysis.

SOLUBILITY OF CUPRIC FORMATE IN FORMIC ACID
SOLUTIONS OF AMMONIUM FORMATE
(Davidson and Holm, 1931)

t°	Mol. Ratio NH_4CHO_2 in Solvent	Mols. $\text{Cu}(\text{CHO}_2)_2$ per 100 mols. $\text{Cu}(\text{CHO}_2)_2 + \text{NH}_4\text{CHO}_2 + \text{HCOOH}$
33.5	0.10	0.055*
36.5	"	0.066*
39.0	"	0.076*
41.0	"	0.083*
44.0	"	0.098*
65.0	"	0.076
71.0	"	0.083
77.0	"	0.098
60.0	0.1973	0.319
70.5	"	0.399
77.2	"	0.465
51.5	0.2975	1.016

*Unstable modification

(Cont.)

Cu CUPRUM

SOLUBILITY OF CUPRIC FORMATE IN FORMIC ACID SOLUTIONS OF AMMONIUM FORMATE--Contd.

t*	Mol. Ratio NH_4CHO_2 in Solvent	Mols. $\text{Cu}(\text{CHO}_2)_2$ per 100 mols. $\text{Cu}(\text{CHO}_2)_2 + \text{NH}_4\text{CHO}_2 + \text{HCOOH}$
68.5	0.2975	1.286
74.0	"	1.365
29.0	0.3354	1.179
31.0	"	1.308
33.0	"	1.501
38.5	"	1.680
43.0	"	1.950
44.0	"	2.004
37.0	0.4375	1.990
43.0	"	2.470
48.5	"	2.816
51.5	"	3.131

At NH_4CHO_2 concentrations below 0.3 mol. ratio the bright blue solid phase could not be obtained in sufficient quantity for analysis. At higher NH_4CHO_2 concentrations the solid phase was pale blue $2\text{Cu}(\text{CHO}_2)_2 \cdot 3\text{HCOOH}$.

CH CUPRIC ACETATE $\text{Cu}(\text{CH}_3\text{COO})_2$

SOLUBILITY IN WATER AT 25°

6.79 gms. $\text{Cu}(\text{CH}_3\text{COO})_2$ per 100 gms. sat. sol. (Sandved, 1927)
6.85 gms. $\text{Cu}(\text{CH}_3\text{COO})_2$ per 100 cc sat. sol. (d. = 1.05) (Buttgenbach, 1925)

SOLUBILITY OF COPPER ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25° (Sandved, 1927)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$	$\text{HC}_2\text{H}_3\text{O}_2$		$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$	$\text{HC}_2\text{H}_3\text{O}_2$	
6.79	0.0	CuI	0.69	75.74	1.1.1
4.73	6.18	"	0.48	81.60	"
4.27	11.14	"	0.25	88.46	"
4.16	13.65	"	0.22	92.17	"
3.49	22.35	"	0.21	93.33	"
3.12	28.43	"	0.20	94.94	"
2.68	35.53	"	0.21	95.26	"
2.10	46.08	"	0.17	95.50	" + 1.1
1.70	53.35	"	0.23	95.66	1.1
1.18	63.67	"	0.23	96.37	"
0.89	70.81	"	0.31	97.20	"
0.79	74.06	" + 1.1.1	0.71	98.77	"
0.77	74.42	1.1.1	0.71	98.91	"

$\text{CuI} = \text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$; 1.1.1 = $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{HC}_2\text{H}_3\text{O}_2 \cdot \text{H}_2\text{O}$;
1.1 = $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{HC}_2\text{H}_3\text{O}_2$.

THE SYSTEM - POTASSIUM ACETATE - WATER AT 25°
(Buttgenback, 1925)

The original determinations were evidently published in the author's dissertation (Aachen, 1925). Since this was not available the following approximate values were read from the small scale diagram given in the condensed account of the work published in the Z. anorg. allgem. chem.

d_{25} of sat. sol.	Gms. per 100 cc sat. sol.		Solid Phase	d_{25} of sat. sol.	Gms. per 100 cc sat. sol.		Solid Phase	
	Cu	CH ₃ COOK			Cu	CH ₃ COOK		
1.05	2.4	0.0	Cu(CH ₃ COO) ₂ ·H ₂ O	1.27	2.0	52.0	1.1.1	
1.06	1.4	7.0	"	1.31	1.65	64.0	"	CH
1.10	1.3	12.0	"	1.33	1.8	72.0	"	
1.12	1.4	17.0	"	1.34	1.95	74.0	" + 1.3	
1.14	1.6	22.0	"	1.36	1.4	84.0	1.3	
1.16	2.0	28.5	"	1.38	1.7	100.0	"	
1.19	2.4	34.0	"	-	0.15	112.0	1.3+CH ₃ COOK·1½H ₂ O	
1.23	3.0	41.0	" + 1.1.1	-	0.00	104.0	CH ₃ COOK·1½H ₂ O	
1.25	2.4	46.0	1.1.1					

1.1.1 = Cu(CH₃COO)₂·CH₂COOK·H₂O; 1.3 = Cu(CH₃COO)₂·3CH₃COOK.

A portion of the 40° curve near the tr. pt. 1.1.1 + 1.3 is also given.

THE SYSTEM COPPER ACETATE - ACETIC ACID - DETERMINED
BY THE FREEZING POINT METHOD
(Davidson and Griswold, 1931)

t°	Mols. Cu(C ₂ H ₃ O ₂) ₂ per 100 mols. Cu(C ₂ H ₃ O ₂) ₂ + HC ₂ H ₃ O ₂		Solid Phase	t°	Mols. Cu(C ₂ H ₃ O ₂) ₂ per 100 mols. Cu(C ₂ H ₃ O ₂) ₂ + HC ₂ H ₃ O ₂		Solid Phase
16.65	0.0		Ac	41.5	0.408		1.1
16.63	0.0307		"	45.8	0.487		"
16.50	0.0471		"	48.7	0.584		"
16.43	0.0831		"	56.0	0.768		"
16.57	0.0994		"	55.7	0.773		"
25.3	0.169	1.1		61.0	0.976		"
30.1	0.236	"		91.3	0.844		"
32.1	0.266	"		95.5	0.912		"
35.0	0.305	"		99.0	0.976		"

Cu CUPRUM

SOLUBILITY OF COPPER ACETATE IN ACETIC ACID SOLUTIONS OF AMMONIUM ACETATE, DETERMINED BY THE SYNTHETIC METHOD
(Davidson and Griswold, 1931)

t°	Mol. Per cent NH ₄ C ₂ H ₃ O ₂ in Solvent	Mols. Cu(C ₂ H ₃ O ₂) ₂ per 100 Mols. Cu(C ₂ H ₃ O ₂) ₂ + NH ₄ C ₂ H ₃ O ₂ + HC ₂ H ₃ O ₂	Solid Phase
33.8	7.9	0.624	1.1
37.3	"	0.693	"
40.7	"	0.800	"
45.2	"	0.929	"
32.5	11.6	0.816	"
38.5	"	0.026	"
CH 42.7	"	1.179	"
28.0	15.1	1.005	"
31.8	"	1.072	"
36.8	"	1.273	"
41.2	"	1.488	"
42.7	"	1.746	"
31.5	20.7	0.796	1.4.4
32.5	"	1.188	"
33.5	"	1.584	"
37.0	"	1.708	1.1
40.7	"	1.766	"
41.8	"	1.800	"
31.0	22.1	0.777	1.4.4
34.0	"	1.125	"
34.0	"	1.399	"
48.0	23.7	0.448	"
50.5	"	0.532	"
54.0	"	0.765	"

1.1 = Cu(C₂H₃O₂)₂·HC₂H₃O₂; 1.4.4 = Cu(C₂H₃O₂)₂·4NH₄C₂H₃O₂·4HC₂H₃O₂.

SOLUBILITY OF COPPER ACETATE IN ACETIC ACID SOLUTIONS OF POTASSIUM ACETATE, DETERMINED BY THE SYNTHETIC METHOD
(Davidson and Griswold, 1935)

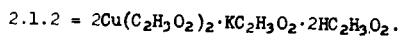
t°	Mol. Fraction KC ₂ H ₃ O ₂ in Solvent	Mols. Cu(C ₂ H ₃ O ₂) ₂ per 100 Mols. Cu(C ₂ H ₃ O ₂) ₂ + KC ₂ H ₃ O ₂ + HC ₂ H ₃ O ₂	Solid Phase
31.8	0.0146	0.350	1.1
38.3	"	0.476	"
42.3	"	0.557	"
45.3	"	0.632	"
48.3	"	0.723	"
31.3	0.0254	0.392	"
34.0	"	0.435	"
42.0	"	0.590	"
48.0	"	0.752	"
51.0	"	0.843	"

1.1 = Cu(C₂H₃O₂)₂·HC₂H₃O₂

(Cont.)

SOLUBILITY OF COPPER ACETATE IN ACETIC ACID SOLUTIONS OF POTASSIUM ACETATE, DETERMINED BY THE SYNTHETIC METHOD--Contd.

t°	Mol. Fraction KC ₂ H ₃ O ₂ in Solvent	Mols. Cu(C ₂ H ₃ O ₂) ₂ per 100 Mols. Cu(C ₂ H ₃ O ₂) ₂ + KC ₂ H ₃ O ₂ + HC ₂ H ₃ O ₂	Solid Phase
32.0	0.0486	0.530	2.1.2
36.8	"	0.623	"
41.0	"	0.711	"
44.0	"	0.800	"
48.0	"	0.916	"
29.8	0.0590	0.440	"
35.7	"	0.520	"
44.2	"	0.706	"
48.5	"	0.804	"
58.5	"	1.100	"
27.0	0.0657	0.378	"
35.5	"	0.495	"
41.5	"	0.599	"
48.5	"	0.745	"
60.5	"	1.100	2.1.2
26.0	0.0738	0.373	"
35.5	"	0.497	"
45.8	"	0.676	"
49.0	"	0.746	"
52.0	"	0.814	"
27.1	0.107	0.409	"
38.3	"	0.557	"
44.6	"	0.654	"
52.3	"	0.817	"
56.8	"	0.927	"
29.3	0.116	0.454	"
36.8	"	0.549	"
45.7	"	0.700	"
51.8	"	0.832	"
62.0	"	1.100	"
43.6	0.144	0.800	"
49.1	"	0.923	"
51.7	"	0.980	"
57.3	"	1.110	"
61.3	"	1.240	"



SOLUBILITY OF COPPER (1c) ACETATE IN ACETIC ACID SOLUTIONS OF ACETAMIDE AT 35°

(Sisler, Davidson, Stoerner, and Lyon, 1944)

Solvent: Mole Ratio	$\frac{\text{CH}_3\text{CONH}_2}{\text{CH}_3\text{CONH}_2 + \text{CH}_3\text{COOH}}$	Mole % Cu(C ₂ H ₃ O ₂) ₂ in Sat. Sol. at 35°
	0.000	0.31
	.050	.43
	.092	.55
	.164	.78

Cu CUPRUM

SOLUBILITY OF ANHYDROUS COPPER ACETATE IN PYRIDINE (Mathews and Benger, 1914)

Gms. Cu(C ₂ H ₃ O ₂) ₃ per 100 Gms.			Gms. Cu(C ₂ H ₃ O ₂) ₃ per 100 Gms.		
t°	Sat. Sol.	Solid Phase	t°	Sat. Sol.	Solid Phase
-11.6	0.37	Cu(C ₂ H ₃ O ₂) ₂ ·4C ₅ H ₅ N	45.2	4.17	Cu(C ₂ H ₃ O ₂) ₃ ·4C ₅ H ₅ N
+ 2	0.6	"	34.8	3.75	Cu(C ₂ H ₃ O ₂) ₂ ·C ₅ H ₅ N
13	1.03	"	55.7	4.13	"
26.45	1.61	"	64.3	4.48	"
37.4	2.83	"	76.2	4.83	"
41.9	3.12	"	83.3	5.40	"
43.2	3.39	"	95.4	6.31	"

Transition point = 44.7°

SOLUBILITY OF COPPER ACETATE IN OTHER ORGANIC SOLVENTS

100 gms. Acetone (CH₃COCH₃) dissolve 0.28 gm. Cu(C₂H₃O₂)₂ at 15°.
(Henstock, 1934)

100 gms. Methyl Alcohol (CH₃OH) dissolve 0.48 gm. Cu(C₂H₃O₂)₂ at 15° and 0.48 gm. at 66° (b.pt.). (Henstock, 1934)

100 gms. glycerol (d₁₅ = 1.256 = 96%) dissolve 10 gms. copper acetate at 15°-16°. (Ossendowski, 1907)

COPPER TRIFLUOROACETATE Cu(CF₃COO)₂

Solvent t° Solubility

H₂O 20 74 gms. Cu(CF₃COO)₂ per 100 gms. sat. sol. (Swarts, 1939)
CF₃COOH 29.8 19.73 gms. Cu(CF₃COO)₂ per 100 gms. CF₃COOH (Hara and Cady, 1954)

CH COPPER PHENYLACETATE Cu(C₆H₅CH₂COO)₂ COPPER DIPHENYL ACETATE Cu[(C₆H₅)₂CHCOO]₂

SOLUBILITY OF EACH (SEPARATELY) IN ETHANOL - BENZENE MIXTURES AT 25°
(Crawford, 1950, 1950a)

Solvent	Gms. per 100 ml. solvent	
	Cu phenylacetate	Cu diphenylacetate
Benzene	~0	~0
" + 10 vol. % C ₂ H ₅ OH	2.73	7.65
" + 17 " " "	4.1	10.6 (max.)
" + 25 " " "	4.5 (max.)	8.8
" + 50 " " "	3.0	4.4
100 % C ₂ H ₅ OH	0.5	0.1

COPPER PROPIONATE $\text{Cu}(\text{CH}_3\text{CH}_2\text{COO})_2$ COPPER BUTYRATE $\text{Cu}(\text{CH}_3\text{CH}_2\text{CH}_2\text{COO})_2$

CH

At 25° 100 cc of a Benzene + 10 vol. % Ethanol dissolves 7.64 gms. copper propionate.

At 25° 100 cc of a Benzene + 10 vol. % Ethanol dissolves 18.3 gms. copper butyrate. (Crawford, 1950a)

COPPER RUBANATE $\text{Cu}(\text{HNSCCSNH})_2$?

The Ksp in H_2O and dilute acid and base solutions is 7.67×10^{-16} . (Malyuga, 1955)

COPPER TARTRATE $\text{CuC}_4\text{O}_6\text{H}_4 \cdot 3\text{H}_2\text{O}$

SOLUBILITY IN WATER
(Cantoni and Zachoder, 1905)

Gms. CuC ₄ O ₆ H ₄ · 3H ₂ O per 100 cc Solution		Gms. CuC ₄ O ₆ H ₄ · 3H ₂ O per 100 cc Solution		Gms. CuC ₄ O ₆ H ₄ · 3H ₂ O per 100 cc Solution	
t°		t°		t°	
15	0.0197	40	0.1420	65	0.1767
20*	0.0420	45	0.1708	70	0.1640
25	0.0690	50	0.1920	75	0.1566
30	0.0890	55	0.2124	80	0.1440
35	0.1205	60	0.1970	85	0.1370

*100 cc of aqueous saturated solution of copper tartrate contain 2.3×10^{-4} gm. mols. or 0.061 gms. $\text{CuC}_4\text{O}_6\text{H}_4 \cdot 3\text{H}_2\text{O}$ at 18°. (Kolthoff, 1926)

COPPER FUMARATE $\text{CuC}_4\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

CH

100 gms. H_2O dissolve 0.02 gm. $\text{CuC}_4\text{H}_2\text{O}_4$ at 30°. (Weiss and Downs, 1923.)

COPPER MALEATE $\text{CuC}_4\text{H}_2\text{O}_4 \cdot \text{H}_2\text{O}$

100 gms. H_2O dissolve 0.12 gm. $\text{CuC}_4\text{H}_2\text{O}_4$ at 30°. (Weiss and Downs, 1923.)

COPPER CITRATE $\text{Cu}_3[\text{CH}_2)_2\text{COH}(\text{COO})_3]_2$

At 25°, 0.17 gms. Copper Citrate dissolve in sea water of pH 8.1. (Ferry and Riley, 1946).

Cu CUPRUM

COPPER POTASSIUM CITRATE $\text{CuK}_4[(\text{COOCH}_2)_2\text{C}(\text{OH})\text{COO}]_2$

100 cc sat. solution in H_2O contain 43.3 gms. of the salt at 10° . (Pickering, 1915)

COPPER PYRIDINE-RHODINATE $\text{C}_5\text{H}_5\text{NCuCNS ?}$

0.00055 moles are dissolved in one liter of a saturated solution in water. 0.0117 mols. are dissolved in one liter of a saturated solution in absolute alcohol. (Probably at 20°) (Treadwell and Ammann, 1938).

CH COPPER CUPFERRATE (Salt of Nitrosophenyl hydroxylamine) $\text{Cu}(\text{C}_6\text{H}_5\text{N}(\text{NO})\text{O})_2$

100 gms. H_2O dissolve $1.1 \cdot 10^{-5}$ gms. of the compound at 18° . (Pinkus and Martin, 1927)

The solubility product is 9.5×10^{-17} (Pyatnitski, 1946).

0.00013 moles are dissolved in one liter of a saturated solution in water which is 0.01 N with Acetic Acid. (Probably at 20°) (Treadwell and Ammann, 1938).

Data for the distribution of copper cupferrate between chloroform and water as a function of acid and cupferron concentrations are given by Furman, Mason and Pekola, 1949.

COPPER BENZOATE $\text{Cu}(\text{C}_6\text{H}_5\text{COO})_2$

Solvent	t°	Solubility	Author
Water	20	0.100 gms. $\text{Cu}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 cc sat. sol. (Solid phase = tetrahydrate)	(Ephraim and Pfister, 1925)
Acetone	15	2.03 gms. per 100 gms. acetone	(Henstock, 1934)
Methanol	15	0.49 gms. per 100 gms. methanol	(" ")
	66	1.97 " " " "	(" ")
Benzene + 10 vol. % $\text{C}_2\text{H}_5\text{OH}$	25	0.13 gms. per 100 ml. solvent	(Crawford, 1950)

CH COPPER BENZOATES (Substituted)

SOLUBILITY OF COPPER BENZOATES IN WATER AT 20° (Ephraim and Pfister, 1925)

Compound	Formula	Gms. anhydrous compd. per 100 cc sat. sol.
Copper benzoate	$(\text{C}_6\text{H}_5 \cdot \text{COO})_2\text{Cu} \cdot 4\text{H}_2\text{O}$	0.100
" -4-Chloro benzoate	$(\text{C}_6\text{H}_4\text{Cl} \cdot \text{COO})_2\text{Cu} \cdot 2\text{H}_2\text{O}$	0.192
" -4-Nitro "	$(\text{C}_6\text{H}_4\text{NO}_2 \cdot \text{COO})_2\text{Cu} \cdot \text{H}_2\text{O}$	0.161
" -4-Oxy "	$(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Cu} \cdot 7\text{H}_2\text{O}$	0.242
" cinnamate	$\text{C}_{18}\text{H}_{14}\text{O}_4 \cdot \text{Cu}$	0.0304

SOLUBILITY OF COPPER BENZOATES IN BENZENE-ETHANOL
(10 VOL. % C_2H_5OH) MIXTURES AT 25°
(Crawford and Stewart, 1953, 1950a)

The corresponding para-derivatives are practically insoluble.

Compound	Gms. Cu Salt per 100 gms. solvent
Copper o-fluorobenzoate	3.0
" o-chlorobenzoate	2.5
" o-toluate	6.0
" p-toluate	0.01*
" α -naphthoate	5.9
" o-ethyl benzoate	16.8
" p-ethyl benzoate	0.72
" 2,6 dimethyl benzoate	40.
" 2,4,6 trimethyl benzoate	35.
" m-methyl benzoate	1.9
" m-ethyl benzoate	3.1
" m-n-propyl benzoate	3.0
" o-bromobenzoate	5.7
" o-iodobenzoate	6.0
" diphenyl-2-carboxylate	20.
" o-isopropyl benzoate	23.
" o-t-butyl benzoate	35.
" p-isopropyl benzoate	0.74
" 4-t-butyl-2,6-dimethyl benzoate	30.
" 2 methyl-1 naphthoate	35.
" m-1-propyl benzoate	3.0
" m-t-butyl benzoate	4.8
" cinnamate	0.44*
" crotonate	0.31*

*gms. per 100 ml. solvent

COPPER ANTHRANILATE $Cu(H_2HC_6H_4COO)_2$

CH

0.000903 moles are dissolved in one liter of a saturated solution which is 1N with Acetic Acid. (Probably at 20°) (Treadwell and Ammann, 1938)

COPPER TETRACHLOROPHTHALATE $C_6Cl_4(COO)_2Cu$

Less than 0.10 gms. are dissolved in 100 gms. of a saturated solution in water at 25°. (Lawlor, 1947).

COPPER SALICYLALDOXIME $Cu[HO(C_6H_4)CHNO]_2$

0.00022 moles are dissolved in one liter of a saturated solution which is 0.01 N with HCl. (Probably at 20°) (Treadwell and Ammann, 1938)

Cu CUPRUM

CH COPPER BENZOINOXIME $\text{Cu}[\text{C}_6\text{H}_5\text{CHOHCHO}(\text{C}_6\text{H}_5)]_2$

0.00078 moles are dissolved in one liter of a saturated solution which is 0.01 N with Acetic Acid. (Probably at 20°) (Treadwell and Ammann, 1938)

COPPER 8-HYDROXY QUINOLATE (OXINE) $\text{Cu}(\text{C}_9\text{H}_6\text{ON})_2 \cdot 2\text{H}_2\text{O}$

The solubility product in water is given as 5×10^{-29} by Borrel and Paris (1952) and 4.2×10^{-24} by Tinovskaya (1950). Treadwell and Ammann (1938) found 0.000570 moles dissolved in one liter of 1N acetic acid (20°). Moeller (1943) found the extraction from water with CHCl_3 to be "complete" between pH 2.7 - 7.0. Similar data are reported by Gentry and Sherrington (1950).

The solubility (mole fraction) in benzene at 25° is 0.000032. (Charles and Freiser, 1951)

The Ksp of Copper 2-methyl-8 hydroxy quinolate is 4×10^{-26} at room temperature. (Borrel and Paris, 1952)

COPPER SULFONATES

SOLUBILITY OF SEVERAL COPPER SULFONATES IN WATER

Compound	Formula	t°	Gms. anhydrous compd. per 100 cc sat. sol.
Copper Benzene sulfonate	$\text{Cu}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	18	32.33 (2)
" " "	"	34	39.26 (2)
" " "	"	49.5	49.70 (2)
" " "	$\text{Cu}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 2\text{H}_2\text{O}$	50.0	48.89 (2)
" " "	"	64.5	55.92 (2)
" " "	"	80.5	66.24 (2)
" Naphthalene-1-sulfonate	$\text{Cu}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	17	4.647 (2)
" " -2- "	"	20	1.07 (2)
" " -2- "	"	32	1.49 (2)
" " -2- "	"	45	2.26 (2)
" " -2- "	"	59	3.80 (2)
" " -2- "	"	74	6.54 (2)
" " -2- "	"	82	9.42 (2)
" " -6-oxy-2- "	$\text{Cu}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 7\text{H}_2\text{O}$	20	1.249 (1)
" " -5-chlor-1-sulfonate	$\text{Cu}(\text{C}_{10}\text{H}_6\text{SO}_3\text{Cl})_2 \cdot 4\text{H}_2\text{O}$	20	1.088 (1)
" Anthracene-1-sulfonate	$\text{Cu}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	20	0.0806 (1)
" " -2- "	$\text{Cu}(\text{C}_{14}\text{H}_9\text{SO}_3)_2$	20	0.0083 (1)
" 2-phenanthrene monosulfonate	$\text{Cu}(\text{C}_{14}\text{H}_9\text{SO}_3)_2$	20	0.25 (4)*
" 3- " "	"	20	0.09 (4)*
" 10- " "	"	20	0.26 (4)*
" -10-Chlorphenanthrene-3 or 6- "	$\text{Cu}(\text{C}_{14}\text{H}_9\text{ClSO}_3)_2 \cdot 4\text{H}_2\text{O}$	20	0.010 (3)

(1) Ephraim and Pfister, 1925a; (2) Ephraim and Seger, 1925; (3) Sandquist, 1917; (4) Sandquist, 1912. *Gms. per 100 gms. H_2O .

The Ksp of copper 8-quinolinol-5-sulfonate is $10^{-13.1}$ at 25°. (Nasanen and Uusitalo, 1954)

COPPER QUINOLINE CARBOXYLATES

Compound	Formula	Moles compd. per liter H ₂ O
Copper 8-quinoline carboxylate	$\text{Cu}(\text{C}_9\text{H}_6\text{NCOO})_2$	0.0180
" 2- " "	"	.0811
" 6- " "	"	.000900

(Lumme, 1955)

COPPER DITHIZONATES (diphenyl thiocarbazones)

CH

Compound	Moles per liter Sat. Sol. in	
	CCl_4	H_2O
$\text{Cu}(\text{HD})_2$	5.5×10^{-4}	8×10^{-9}
CuD	1×10^{-3}	6×10^{-8}
H_2D	2.1×10^{-3}	2×10^{-7}

(Geiger and Sandell, 1953)

COPPER(OUS) DIAZOAMIDOBENZENE $\text{Cu}(\text{C}_6\text{H}_5\text{N} = \text{N} - \text{NC}_6\text{H}_5)$

One liter Methyl alcohol dissolve less than 0.001 gm. $\text{Cu}(\text{C}_6\text{H}_5\text{N} = \text{N} - \text{NC}_6\text{H}_5)$ at 25°.

One liter Ethyl alcohol dissolve less than 0.0022 gm. $\text{Cu}(\text{C}_6\text{H}_5\text{N} = \text{N} - \text{NC}_6\text{H}_5)$ at 25°.

One liter n Propyl alcohol dissolve less than 0.0084 gm. $\text{Cu}(\text{C}_6\text{H}_5\text{N} = \text{N} - \text{NC}_6\text{H}_5)$ at 25°. (Watt and Fernelius, 1935)

COPPER HELIANTHATE $(\text{C}_{14}\text{H}_{14}\text{H}_3\text{SO}_3)_2\text{Cu} \cdot 4\text{H}_2\text{O}$

1000 cc H_2O dissolve 0.122 gm. of the hydrated salt at 20-25°. (Stark and Dehn, 1918)

COPPER ANTHRAQUINONE DISULFINATES $\text{Cu}(\text{C}_{14}\text{H}_6\text{O}_2(\text{SO}_2)_2)$

CH

(Data of Kozlov and Smolin, 1949)

Salt	t°	Solubility in water (Salt:H ₂ O by weight)
1,5- $\text{Cu}(\text{C}_{14}\text{H}_6\text{O}_2(\text{SO}_2)_2) \cdot 2\text{H}_2\text{O}$	25	1:75
	100	1:25
1,8- $\text{Cu}(\text{C}_{14}\text{H}_6\text{O}_2(\text{SO}_2)_2) \cdot 3\text{H}_2\text{O}$	20	1:125
	100	1:115

Cu CUPRUM

COPPER STEARATE $\text{Cu}(\text{C}_{17}\text{H}_{35}\text{COO})_2$

At 25°, $7 (\pm 2) \times 10^{-9}$ gms. dissolve in 100 gms. H_2O .

At 25°, $8 (\pm 2) \times 10^{-7}$ gms. dissolve in 100 gms. Benzene.

(Dobry, 1954)

CH COPPER CUPROINE COMPLEX (2,2' diquinolyl)

At 25° the distribution constant between water and 180 amyl alcohol is $\text{alc}/\text{H}_2\text{O} = 1680$. (Hoste, Eeckhout and Gillis, 1953)

(NH_3) CUPRIC AMMINES

SOLUBILITY OF COPPER AMMINES IN AQUEOUS ALCOHOL AT 16° (Ephraim and Mosimann, 1922)

The solvent was in all cases a mixture of 66.6 vol. per cent of aqueous ammonia of $d_{16} = 0.912$ and 33.3 vol. per cent of 96% alcohol.

Compound	Formula	Per liter of sat. sol.	
		Gms. Cu	Gms. mols. salt
Copper hexamine Bromide	$[\text{Cu}(\text{NH}_3)_6]\text{Br}_2$	5.086	0.0903
" " Chloride	" Cl_2	47.7	0.757
" " Iodide	" I_2	4.11	0.065
" " Nitrate	" $(\text{NO}_3)_2$	10.15	0.161
" " Sulfate	" SO_4	0.0425	0.00063

Data for the solubility of the blue cupro-cupri-cyanide-ammonia salt, $\text{Cu}_2(\text{CN})_4(\text{NH}_3)_4\text{Cu}$ and of the corresponding green salt, $\text{Cu}_2(\text{CN})_4(\text{NH}_3)_3\text{Cu}$ in ammonia water of various concentrations, are given by Benrath and Schröder, 1924. It was desired to learn by solubility determinations whether the ammonia rich salt could be obtained from the ammonia poor salt by treatment of the latter with aqueous ammonia.

CN CUPROUS CYANIDE CuCN

2.6 mg. dissolve in 1 liter of distilled water at 18°. 6.0 mg. dissolve in 1 liter of Baltic Sea Water at 18°. (Ragg, 1950)

SOLUBILITY IN AQUEOUS HCN SOLUTIONS CONTAINING OTHER ACIDS AT 25° (Vladimirova and Kokovskii, 1950)

The authors determined the solubility of CuCN in solutions containing 0.1-1.0 M HCl plus varying amounts of HCl or H_2SO_4 . The instability constant of the ion $\text{Cu}(\text{CN})_2^-$ averaged 1.2×10^{-5} .

THE SYSTEM CUPROUS CYANIDE - POTASSIUM CYANIDE - WATER AT 25°
(Bassett and Corbet, 1924)

Note:-Difficulty was experienced in preparing KCN free from KOH. It was necessary to prepare the saturated solutions from double salts which could be obtained free of KOH. Constant rotation in wax bottles was employed. To eliminate errors due to oxidation, an atmosphere of coal gas, which had been previously washed by passing through solutions of lead acetate and sodium hydroxide was maintained in the bottles. Both the liquid and solid phases were analyzed.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			CN
KCN	CuCN	Solid Phase	KCN	CuCN	Solid Phase	
41.7	0.00	KCN	22.32	14.71	KCu(CN) ₂	
40.53	2.16	"	19.95	13.78	"	
40.31	4.20	"	12.10	8.84	"	
41.70	5.84	K ₃ Cu(CN) ₄	9.97	7.52	KCu ₂ (CN) ₃ ·H ₂ O	
35.96	10.86	"	6.05	3.93	"	
33.86	15.30	"	6.03	3.88	"	
41.94	6.13	K ₃ Cu(CN) ₃ ·H ₂ O	4.21	1.87	"	
36.24	12.92	"	3.27	1.68	"	
34.82	18.47	"	1.34	0.60	"	
35.28	22.52	"	0.42	trace	" + CuCN	
34.77	22.59	KCu(CN) ₂	trace	trace	CuCN	

Freezing-point data for CuCN + KCN and CuCN + NaCN are given by Truthe (1912).

CUPRIC FERROCYANIDE CuK₂Fe(CN)₆

CN

A saturated solution in water at room temp. contains 1.0×10^{-5} gm. ions Cu⁺⁺ per liter. (Tananaev, Glushkova and Seifer, 1956)

COPPER NITRO PRUSSIAE CuFe(CN)₅NO

One liter sat. solution of Copper Nitroprussiate in Water contains 6.0×10^{-5} gm. mol. CuFe(CN)₅NO at 20°. (Tomicek and Kubik, 1937)

CUPROUS THIOCYANATE CuSCN

CNS

Data for the solubility of CuSCN in HCN solutions is given by Vladimirova and Kokovskii, 1950. 0.46 mmol. of Cu₂(SCN)₂ dissolve in 1 liter of 50% ZnSO₄ solution at 20°. (Neiman, Miller and Fedoseeva, 1950)

At 18°, 1 liter distilled water dissolve 4.4 mg. CuSCN. 1 liter of Baltic Sea water at 18° contains 2.2 mg. (Ragg, 1950)

Cu CUPRUM

CNS CUPRIC THIOCYANATE $\text{Cu}(\text{SCN})_2$

SOLUBILITY OF $\text{Cu}(\text{SCN})_2$ IN AQUEOUS AMMONIA SOLUTIONS AT 25° AND AT 40°
(Horn, 1907)

d ₂₅ Sat. Sol.	Results at 25°			Results at 40°		
	Gms. per 100 gms. Sat. Sol.		Solid Phase	Gms. per 100 gms. Sat. Sol.		Solid Phase
	NH ₃	$\text{Cu}(\text{SCN})_2$		NH ₃	$\text{Cu}(\text{SCN})_2$	
1.0082	0.79	2.45	$\text{Cu}(\text{SCN})_2 \cdot 2\text{NH}_3$	0.94	2.81	$\text{Cu}(\text{SCN})_2 \cdot 2\text{NH}_3$
1.0166	1.98	4.08	"	1.77	4.18	"
1.0213	2.50	5.11	"	2.57	6.55	"
1.0171	4.26	5.96	$\text{Cu}(\text{SCN})_2 \cdot 4\text{NH}_3$	3.52	8.76	"
1.051	5.35	6.22	"	4.35	11.78	$\text{Cu}(\text{SCN})_2 \cdot 4\text{NH}_3$
1.0134	6.39	6.59	"	5.50	12.07	"
1.0070	9.93	7.98	"	7.58	12.99	"
0.9987	16.55	11.24	"	13.98	16.58	"
0.9985	21.47	15.22	"	18.02	19.76	"

COPPER CARBONATE CuCO_3

CO

100 gms. of a sat. solution of copper carbonate in water at 18° and in contact with CO_2 at a pressure of 1 atmosphere, contain 0.03 gm. CuCO_3 . At a pressure of 56 atmospheres of CO_2 the sat. solution contains 0.041 gm. CuCO_3 . (Haehnel, 1924)

COPPER potassium CARBONATE $\text{CuK}_2(\text{CO}_3)_2$

SOLUBILITY OF MIXTURES OF COPPER CARBONATE AND POTASSIUM
CARBONATE IN WATER AT 25°
(Wood and Jones, 1907-08)

100 gms. H_2O dissolve 3.15 gms. CuCO_3 + 105 gms. K_2CO_3 at 25° when the solid phase in contact with the solution is $\text{CuCO}_3 \cdot \text{K}_2\text{CO}_3$ + K_2CO_3 .

Additional points on the curves were determined but the analytical data are not given. The following approximate values were read from the curve for the double salt, $\text{CuCO}_3 \cdot \text{K}_2\text{CO}_3$:

Gms. per 100 Gms. H_2O		Solid Phase
K_2CO_3	CuCO_3	
105	3.15	K_2CO_3 + $\text{CuCO}_3 \cdot \text{K}_2\text{CO}_3$
100	3.20	$\text{CuCO}_3 \cdot \text{K}_2\text{CO}_3$
90	3.40	"
85	3.60	"

The triple point for double salt + CuCO_3 could not be determined since CuCO_3 is not capable of existing alone and decomposes into CO_2 + $\text{Cu}(\text{OH})_2$.

COPPER Sodium CARBONATE $\text{CuNa}_2(\text{CO}_3)_2 \cdot 3\text{H}_2\text{O}$ SOLUBILITY OF MIXTURES OF COPPER SODIUM CARBONATE AND SODIUM
BICARBONATE IN WATER AT 18°
(Appleby and Lance, 1918)

Gms. per liter of sat. solution			Solid Phase
Na_2CO_3	NaHCO_3	Cu	
9.27	87.79	-	$\text{CuNa}_2(\text{CO}_3)_2 \cdot 3\text{H}_2\text{O}$
11.08	86.45	0.0509	" + NaHCO_3
13.44	85.27	0.0542	" "
96.68	65.31	0.1061	" "
168.75	53.60	0.1553	" "
185.02	53.77	-	" " + $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
197.08	18.94	0.257	" + $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

No evidence of the presence of trona ($\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$) at 18° was obtained.

COPPER CARBONATE (Basic)

CO

SOLUBILITY IN AQUEOUS CO_2 SOLUTIONS AT 30°
(Free, 1908)

Aq. 0.5 N Na_2CO_3 and 0.5 N CuSO_4 were mixed and the precipitate washed and suspended in H_2O containing CO_2 at a pressure slightly above atmospheric, for 3 days. The filtered precipitate was kept in water ready for use. In the fresh condition or dried, the molecular ratio of the constituents was found to be $1\text{CuO}:0.515\text{CO}_2:0.61\text{H}_2\text{O}$. For the solubility determinations, about 2 gms. of the precipitate were suspended in 600 cc of H_2O and CO_2 passed in to the desired concentration. The mixture was shaken frequently for 3 days. The total CO_2 in the sat. solution was determined and the free CO_2 calc. by difference, assuming that the amount combined to the Cu was in the molecular ratio $2\text{CuO}:1\text{CO}_2$.

Parts per Million		Parts per Million	
Free CO_2	Metallic Cu	Free CO_2	Metallic Cu
0=pure H_2O	1.5	859	28
157	8.3	961	31
277	13.7	1158	33.7
348	17	1224	34.8
743	25.7	1268-1549	35.3-39.7*

*Saturated with CO_2 at 1 + atmosphere.

Results practically identical with the above were obtained for a NaCl solution containing 100 parts per million. Data for other concentrations of NaCl and for other salts are also given. Salts with a common ion depress the solubility. Those with no common ion increase it slightly. A recalculation of the results of Free is given by Seyler (1908).

Cu CUPRUM

SOLUBILITY OF MALACHITE ($\text{CuCO}_3 \cdot \text{Cu(OH)}_2$) AND AZURITE ($2\text{CuCO}_3 \cdot \text{Cu(OH)}_2$) IN DISTILLED WATER CONTAINING CARBON DIOXIDE AT 20° (Tronstad and Veimo, 1940)

$\text{CuCO}_3 \cdot \text{Cu(OH)}_2$	Gms. CO_2 per liter	0	0.29	0.88
	Mg. Cu per liter	0.3	21.0	34.0
$2\text{CuCO}_3 \cdot \text{Cu(OH)}_2$	Gms. CO_2 per liter	0	0.34	0.84
	Mg. Cu per liter	0.5	13.0	27.4

100 gms. of a saturated solution in sea water contain 5×10^{-7} gms. of freshly precipitated basic copper carbonate or less than 1×10^{-7} gms. basic Copper Carbonate which has been aged in sea water one year. (25°, pH = 8.1). Ferry and Riley, 1946. 0.6 mg. of basic copper carbonate dissolve in 1 liter of Baltic sea water at 18°. (Ragg, 1950)

CO COPPER OXALATE CuC_2O_4

SOLUBILITY IN WATER

18°	0.0241 gms. per liter	(Britton and Jarrett, 1936)
25°	0.02364 " " "	(Schäfer, 1905)

SOLUBILITY OF COPPER OXALATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 18° (Britton and Jarrett, 1936)

Gm. Mols. per 1000 cc sat. solution		Solid Phase	Gm. Mols. per 1000 cc sat. solution		Solid Phase
H_2SO_4	CuC_2O_4		H_2SO_4	CuC_2O_4	
0.0	0.00015	CuC_2O_4	0.50	0.00336	CuC_2O_4
0.05	0.00039	"	1.00	0.00658	"
0.125	0.00089	"	1.50	0.00969	"
0.25	0.00180	"	1.875	0.01240	"

THE SYSTEM COPPER OXALATE - SODIUM OXALATE - WATER AT 18° (Britton and Jarrett, 1936)

Gm. Mols. per 1000 cc sat. sol.		Solid Phase	Gm. Mols. per 1000 cc sat. sol.		Solid Phase
$\text{Na}_2\text{C}_2\text{O}_4$	CuC_2O_4		$\text{Na}_2\text{C}_2\text{O}_4$	CuC_2O_4	
0.0	0.00015	CuC_2O_4	0.0919	0.0230	1.1.2
0.010	0.00490	"	0.1240	0.0164	"
0.020	0.0093	"	0.1623	0.0124	"
0.040	0.0171	"	0.1670	0.0119	"
0.050	0.0207	"	0.2001	0.00925	" + $\text{Na}_2\text{C}_2\text{O}_4$
0.060	0.0247	"	0.2335	0.0080	$\text{Na}_2\text{C}_2\text{O}_4$
0.0758	0.0322	CuC_2O_4 + 1.1.2	0.2370	0.0060	"
0.0800	0.0328	1.1.2	0.2375	0.0072	"
0.0823	0.0268	"	0.240	0.000	"



CUPROUS CHLORIDE CuCl

SOLUBILITY IN WATER

Because of the rapidity of the air oxidation of cuprous to cupric ion, a reliable estimate of the solubility is difficult to obtain. The value of Noas, 1912 and Kremann and Noss 1912 (1.52%) at 25° seems much too high. Extrapolation of more recent data indicates that the solubility is no more than 0.1% in pure water, and may be of the order of 0.01%. Kepner and Andrews, 1948 found 0.236 gms. CuCl per liter at 25°

Garvish and Galinker, 1955 give the following results at high temperatures. Their data are labeled moles per 100 gms. H_2O , but reasoning from their results with silver halides, the units are probably moles per 1000 gms. H_2O .

t°	Moles CuCl per 1000 gms. H_2O	t°	Moles CuCl per 1000 gms. H_2O	t°	Moles CuCl per 1000 gms. H_2O
160	0.0431	230	0.155	290	0.336
170	.044	240	.16	300	.355
180	.061	250	.173	320	.47
190	.067	260	.23	330	.54
200	.096	270	.27	350	.632
210	.127	280	.299	360	.693
220	.143				

SOLUBILITY OF CUPROUS CHLORIDE IN HYDROCHLORIC ACID SOLUTIONS

Many of the data are open to question because of air oxidation of the cuprous salt. The results of Abel (1901) are irregular and are disputed by Cowdrey and Davis (1949) and Noyes and Chow (1918). There is only rough agreement between the various data given below.

Results of Morozov and Ustavahikova, 1944

Numerical results are given only for the composition of solutions saturated with both CuCl and HCl , and the other data listed below were read from curves drawn by the authors.

Gms. HCl per 100 gms. sat. sol.	Gms. CuCl per 100 gms. Saturated Solution				
	0°	25°	50°	80°	100°
5	1.5	1.5	2	4	5
10	4.5	6	7	10	13
15	8	12.5	14	18	22.5
19.27	-	-	-	-	30.0*
20	11	18.5	21	25	
23.25	-	-	-	29.43*	
25	14	23.5	26		
27.5	-	-	26.0*		
30	16.5	24.9*			
34.7	30.02*				

*Saturated with $\text{CuCl} + \text{HCl}$

(Cont.)

SOLUBILITY OF CUPROUS CHLORIDE IN HYDROCHLORIC ACID SOLUTIONS--Contd.

Results at 0°

(Cowdrey and Davies, 1949)

Equilibrium was approached from both under- and supersaturation in an atmosphere of nitrogen. The presence of acid had little effect.

Added Cl-
(Molarity) Mean solubility
(moles per liter)

Cl

0.2	0.0065 (.0072)*
0.4	.017
0.6	.030
0.8	.050
1.0	.074 (.079)*
1.2	.103
1.4	.144
1.6	.194
1.8	2.48 (.264)*

The ionic strength in each of the above expts. was $\mu = 4.3$, while $H^+ = 0.01$ to 0.04 . Data marked (*) are in neutral solution with no added acid, same ionic strength.

(Engel, 1889, 1895)

Moles per liter Gms. per 100
 gms. sat. sol.

CuCl	HCl	Density	CuCl	HCl
0.048	0.898	1.050	0.448	3.12
.15	1.75	1.049	1.418	6.08
.29	2.60	1.065	2.697	9.32
.45	3.45	1.080	4.127	11.64
.825	4.78	1.135	7.199	15.35
1.55	6.85	1.261	12.46	19.80
3.30	10.40	1.345	24.30	28.45

Results at 15-16° (Engel 1889, 1895)

Note that Engel found a decrease in solubility with increasing temperature.

0.74	5.44	1.19	6.159	16.66
1.08	6.89	1.27	8.422	19.77
1.28	7.50	1.29	9.826	21.19
1.60	9.20	1.38	11.48	24.24

Results at 19° (Fedotieff, 1928)

Gms. per liter sat. sol.

CuCl	HCl
11.1	49.6
74.6	141.2
121.9	182.9
187.4	229.8
217.7	256.0

Results at 25°

Results of Poma, 1909, 1910 with
CuCl₂ added
(Solid phase = CuCl)

Solvent: 1M HCl

Mols. per Liter

CuCl ₂ Added	CuCl ₂ + CuCl
0	0.0862
0.1	0.2017
0.2	0.3256
0.4	0.5707
0.5	0.6924

Solvent: 2M HCl

0	0.2365
0.094	0.3528
0.188	0.4766
0.235	0.5385
0.282	0.6038

Solvent: 4M HCl

0	0.7704
0.095	0.9044
0.189	1.0370
0.379	1.3040
0.473	1.4380

Results of Noyes and Chow, 1918

Sat. Solution:

Moles per 1000

Gms. H₂O

Solvent:

Moles HCl

per liter

Total Cl Total Cu

0.74	5.44	1.19	6.159	16.66	1.1650	1.2815	0.1165
1.08	6.89	1.27	8.422	19.77	0.3165	0.3364	0.01988
1.28	7.50	1.29	9.826	21.19	0.2156	0.2290	0.01340
1.60	9.20	1.38	11.48	24.24	0.0978	0.1038	0.00596

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS
OF CUPRIC CHLORIDE AT 19°
(Fedotieff, 1928)

Gms. per liter sat. solution		Solid Phase	Gms. per liter sat. solution		Solid Phase
CuCl ₂	CuCl		CuCl ₂	CuCl	
134.5	15.8	CuCl	536.5	78.7	CuCl
260.0	40.7	"	661.9	87.4	" + CuCl ₂ ·2H ₂ O
435.7	63.8	"			

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF CUPRIC
SULFATE AT ABOUT 20°
(Bodlander and Storbeck, 1902)

Cl

Millimols per Liter

CuSO ₄	Total Cu	Total Cl	Cu(1c)	Cu(ous)
0	2.880	5.312	2.258	0.622
0.987	3.602	4.908	3.145	0.457
1.975	4.553	4.687	4.131	0.422
2.962	5.193	4.256	4.625	0.509
4.937	7.276	4.329	6.546	0.730

Grams per Liter

0	0.183	0.188	0.143	0.040
0.158	0.229	0.174	0.200	0.029
0.315	0.290	0.166	0.263	0.027
0.473	0.330	0.151	0.292	0.032
0.788	0.463	0.154	0.416	0.046

THE SYSTEM CUPROUS CHLORIDE - FERROUS CHLORIDE - WATER AT 25°
(Kremann and Noss, 1912)

In order to ascertain the composition of the solid phase, the experiment was made by mixing together weighed amounts of H₂O, CuCl and FeCl₂ and agitating in a thermostat at constant temperature. A weighed portion of the clear saturated solution in each case was analyzed and the composition of the solid phase calculated by difference. Note that the value for the solubility of CuCl in water alone is too high.

Gms. per 100 Gms. H ₂ O		Solid Phase	Gms. per 100 Gms. H ₂ O		Solid Phase
FeCl ₂	CuCl		FeCl ₂	CuCl	
0	1.53	CuCl	43.75	12.42	CuCl
6.02	1.33	"	54	17.04	"
11.62	1.80	"	66.40	21.6	"
16.30	3.11	"	73.20	23.20	" + FeCl ₂ ·4H ₂ O
26.30	7.12	"	71.90	21.65	FeCl ₂ ·4H ₂ O
29.35	8.06	"	69.30	11.9	"
33.12	9.56	"	65.10	0	"

Cu CUPRUM

THE SYSTEM CUPROUS CHLORIDE - POTASSIUM CHLORIDE - WATER

Solubility of CuCl In Aq. KCl Solutions at about 20°
(Bodlander and Storbeck, 1902)

Millimols per Liter				
KCl	Total Cu	Total Cl	Cu(ic)	Cu(ous)
0	2.851	5.416	2.222	0.629
2.5	1.955	6.015	1.421	0.534
5	1.522	7.525	1.008	0.514*
10	1.236	11.735	0.475	0.761
20	1.446	21.356	0.324	1.122
50	2.411	not det.	0.1088	2.302
100	4.702	"	0	4.702*
200	9.485	"	0	9.485*
1000	97	"	0	97
2000	384	"	0	384 *

Grams per Liter				
0	0.181	0.193	0.141	0.040
0.186	0.124	0.212	0.090	0.034
0.373	0.097	0.267	0.069	0.033*
0.746	0.079	0.416	0.030	0.048
1.492	0.092	0.759	0.021	0.071
3.730	0.153	not det.	0.007	0.146
7.460	0.299	"	0	0.299*
14.920	0.603	"	0	0.603*
74.60	6.170	"	0	6.170
149.2	24.42	"	0	24.420*

*The results in the 3d, 7th, 8th and last line of this table are at 16°.

Results at 22°
(Bronsted, 1912)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
KCl	CuCl		KCl	CuCl	
3.87	0.115	CuCl	23.57	13.99	CuCl·2KCl
6.56	0.405	"	23.50	11.39	"
8.24	0.861	"	23.49	7.35	"
11.33	2.19	"	24.04	4.53	"
15.30	4.80	"	25.03	3.14	"
17.47	7.19	"	26.28	2.20	"
20.31	10.21	"	27.06	1.60	"
21.64	13.32	"	26.68	1.21	KCl
23.84	17.23	"	26.32	0.58	"
25.24	21.47	"	25.68	0	"
23.87	15.48	CuCl·2KCl			

(Cont.)

Results at 25°
(Valeton and Frömel, 1924)

Mols. per 100 mols. of mixture		Solid Phase	Mols. per 100 mols. of mixture		Solid Phase	Mols. per 100 mols. of mixture		Solid Phase
CuCl	KCl		CuCl	KCl		CuCl	KCl	
0.27	0.09	CuCl	1.75	1.15	1.1.1	0.90	1.15	1.2
0.68	0.18	"	1.66	1.20	"	0.80	1.05	"
0.96	0.25	"	1.65	1.24	"	0.52	0.85	"
1.91	0.54	"	1.55	1.25	"	0.40	0.80	"
2.10	0.62	"	1.44	1.45	"	0.30	0.75	"
2.05	0.90	" + 1.1.1	1.32	1.62	" + 1.2	0.25	0.75	" + KCl
1.97	0.95	1.1.1	1.25	1.55	1.2	0.25	0.85	KCl
1.90	1.00	"	1.25	1.50	"	0.23	0.90	"
1.85	1.05	"	1.10	1.35	"	0.20	1.49	"
1.80	1.10	"	1.00	1.22	"	0.00	8.0	"

1.1.1 = CuCl·KCl·H₂O

1.2 = CuCl·2KCl

THE SYSTEM CUPROUS CHLORIDE - SODIUM CHLORIDE - WATER AT 26.5°
(Kremann and Noss, 1912)

Note that the value for the solubility of CuCl in water alone is too high.

Gms. per 100 Gms. H ₂ O		Solid Phase	Gms. per 100 Gms. H ₂ O		Solid Phase
NaCl	CuCl		NaCl	CuCl	
0	1.55	CuCl	44.14	57.21	CuCl
10.8	3.15	"	55.10	44.10	NaCl
20.7	7.30	"	56.80	41.70	"
27	40.60	"	50.90	18.70	"
36.48	49.10	"			

Ferry and Riley (1946) calculate the solubility of CuCl in sea water to be 0.0031 gms. per cc at 25°, (using oxygen-free water).

THE SYSTEM CuCl + NH₄Cl + H₂O
(Morozov and Ustavshikova, 1944)

The authors present a diagram of the system at 0°, 25°, 50°, 80°, and 100°. Two compounds were identified: 2CuCl·NH₄Cl (at 25°) and CuCl·NH₄Cl (at 50°).

The system CuCl + NH₄Cl + HCl + H₂O was studied at 50°, 80° and 100° by Morozov and Ustavshikova, 1944. Their data are presented in the form of 3 dimensional graphs. The compound CuCl·NH₄Cl exists at 50°. And the compositions of the invariant solutions are given for this temperature. Further data on this system are given by Iguchi and Nakanishi, 1941.

Cu CUPRUM

SOLUBILITY OF CUPROUS CHLORIDE IN ALLYL ALCOHOL SOLUTIONS AT 25° (Kepner and Andrews, 1948; Keefer and Andrews, 1949)

In experiments marked (*), HClO_4 was added to adjust the ionic strength to 0.10 (1949 data). In solutions containing no HCl or HClO_4 , the solid gradually turned red, indicating that hydrolysis had occurred.

Cl	Solvent:		Sat. Solution: total Cu ⁺ Moles per liter	Solvent:		Sat. Solution: total Cu ⁺ Moles per liter
	Moles per liter			Moles per liter		
	Allyl Alcohol	HCl		Allyl Alcohol	HCl	
	0.0	0.0	0.00238	0.0	0.0094	0.00098
	.0101	0.0	.0072	.0101	.00938	.0065*
	.0145	0.0	.00778	.0132	.0094	.00782
	.0200	0.0	.0128	.0202	.00938	.0117*
	.0202	0.0	.0131*	.0264	.0094	.0125
	.0290	0.0	.0137	.0404	.00938	.0207*
	.0300	0.0	.0175*	.0527	.0094	.0246
	.0400	0.0	.0226*	.0658	.0094	.0298
	.0580	0.0	.0256	.0809	.00938	.0378*
	.0724	0.0	.0300	.0986	.0094	.0438
	.0809	0.0	.0393	0.0	.094	.0022
	.0809	0.0	.0394*	.02	.0938	.0125*
	.1086	0.0	.0459	.03	.0938	.0160*
				.04	.0938	.0196*
				.3969	.094	.153
				.5954	.094	.234
				.9923	.094	.406

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF UNSATURATED ALCOHOLS AT 25° (Keefer, Andrews, and Kepner, 1949)

The $[\text{Cl}^-]$ concentration was varied by the addition of HCl . The ionic strength was adjusted in each case $\mu = 0.100$ by addition of HClO_4 .

Moles Unsaturated Alcohol per liter	Moles Cu^+ per liter $\times 10^3$		
	$(\text{Cl}^- = 0)$	$(\text{Cl}^- = 0.100)$	$(\text{Cl}^- = 0.010)$
Ethyl Vinyl Carbinol			
0.092			
0.0929	35.6	30.5	34.2
.0464	21.7	18.4	19.6
.0232	12.8	12.3	
.0116	8.1		
α, α -Dimethyl Allyl Alcohol			
0.0910	31.1	25.3	....
.0682	25.2	20.5	22.5
.0455	18.5	15.8	16.5
.0228	10.9		

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS
OF UNSATURATED ALCOHOLS AT 25°--Contd.

Moles Unsat. Alcohol per liter	Moles Cu ⁺ per liter x 10 ³		
	(Cl ⁻ =0)	(Cl ⁻ =0.100)	(Cl ⁻ =0.010)
3-Methyl-3-Buten-2-ol			
0.0504	9.1	10.0	6.8
.0378	7.7	9.0	5.5
2-Methyl-2-Buten-1-ol			
0.0189	4.9	8.0	3.5
β - Methallyl Alcohol			
		(a)	(b)
0.0708	17.8	15.8	15.0
.0472	13.2	12.1	10.8
.0236	8.1	9.6	
Methyl Vinyl Carbinol			
0.0728	30.6	25.8	...
.0546	24.6	21.1	...
.0364	18.0	16.0	16.2
.0182	10.3		
4-Methyl-4-Penten-2-ol			
0.0336	12.8	11.6	10.3
.0168	7.6	9.0	6.1
.0884	4.3		
γ, γ - Dimethyl Allyl Alcohol			
0.0328	10.7	10.2	7.9
.0164		8.1	5.5
β - Chloro Allyl Alcohol			
.500	8.2	9.5	5.8
Crotyl Alcohol			
		(c)	(d)
0.142	26.8	22.0	23.7
.106	...	17.4	18.7
.0708	...	13.9	
.0688	16.6		
.0342	10.2		

a, b, c, d: Cl⁻ = 0.101, 0.0101, 0.102, 0.0102

Cu CUPRUM

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS
OF UNSATURATED ACIDS AT 25°

(Keefer, Andrews, and Kepner, 1949a)

The $[Cl^-]$ concentration was varied by the addition of HCl. The ionic strength was adjusted in each case to $\mu = 0.100$ by addition of $HClO_4$.

[illegible]

SOLUBILITY OF CuCl IN MALEIC ACID SOLUTIONS AT 25°
(Andrews and Keefer, 1949)

With HCl Added Moles per liter of Sat. Sol.				With KCl Added Moles per liter of Sat. Sol.			
Maleic Acid	HCl	H ⁺	Total Cu ⁺	Maleic Acid	KCl	H ⁺	Total Cu ⁺
0.202	0.0	1.03 ^x	11.8	0.202	0.0	0.067 ^a	24.0
.101	0.0	1.02 ^x	7.7	.101	0.0	.043 ^a	17.0
.0503	0.0	1.02 ^x	4.8	.0504	0.0	.028 ^a	11.8
.202	0.100	1.03 ^x	11.0	.202	0.100	.060 ^a	17.6
.101	.100	1.02 ^x	8.0	.152	.100	.051 ^a	15.4
.0503	.100	1.02 ^x	6.8	.101	.100	.040 ^a	12.8
.184	.0091	1.03 ^x	9.2	.202	.010	.062 ^a	20.2
.101	.0100	1.02 ^x	5.3	.152	.010	.053 ^a	17.3
.0503	.0100	1.02 ^x	3.0	.101	.010	.043 ^a	14.1
.202	0.0	0.138 ⁺	19.2	*Adjusted to $\mu = 1.0$ by addition of HClO ₄ before addition of Maleic Acid and CuCl.			
.152	0.0	.129 ⁺	16.0				
.101	0.0	.122 ⁺	12.8	*Adjusted to $\mu = 0.10$ by addition of HClO ₄ before addition of Maleic Acid and CuCl.			
.0505	0.0	.113 ⁺	8.3				
.202	0.100	.133 ⁺	14.2	^a Adjusted to $\mu = 0.100$ by addition of NaClO ₄ before addition of Maleic Acid and CuCl.			
.152	.100	.126 ⁺	12.4				
.101	.100	.118 ⁺	10.9				
.202	.0100	.136 ⁺	15.8				
.101	.0100	.120 ⁺	9.6				

Cl

SOLUBILITY OF CUPROUS CHLORIDE IN MIXTURES OF MALEIC, FUMARIC,
SULFURIC AND PERCHLORIC ACID SOLUTIONS AT 25°
(Andrews and Keefer, 1948)

The data below represent the increase in the solubility of CuCl when the organic acid is added to the mixture, over the solubility in the absence of the organic acid.

Solubility in Mixtures of Sulfuric and Maleic Acids			Solubility in Mixtures of Perchloric and Maleic Acids		
Gm. mols. H ₂ SO ₄ per liter	Gm. mols. Maleic Acid per liter	Gm. mols. Cu ⁺ per liter	Gm. mols. HClO ₄ per liter	Gm. mols. Maleic Acid per liter	Gm. mols. Cu ⁺ per liter
1.19	0.151	0.0103	0.903	0.146	0.0107
0.595	.152	.0125	.602	.146	.0115
.477	.159	.0132	.421	.146	.0125
.477	.0794	.0069	.301	.146	.0133
.477	.0397	.0034	.120	.146	.0148
.298	.151	.0135	.0602	.146	.0166
.119	.151	.0152			
.0595	.150	.0163			

(Cont.)

Cu CUPRUM

SOLUBILITY IN MIXTURES OF SULFURIC AND FUMARIC ACIDS

Gm. mols. H ₂ SO ₄ per liter	Gm. mols. Fumaric Acid per liter	Gm. mols. Cu ⁺ per liter	Gm. mols. H ₂ SO ₄ per liter	Gm. mols. Fumaric Acid per liter	Gm. mols. Cu ⁺ per liter
Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.	Sat. Sol.
0.477	0.0350	0.0093	.0496	.0504	.0111
.477	.0456	.0107	.0496	.0452	.0115
.477	.0342	.0091	.0496	.0378	.0093
.477	.0504	.0116	.0496	.0339	.0087
.238	.0456	.0100	0.0	.0452	.0103
.094	.0456	.0112	0.0	.0438	.0103

SOLUBILITY OF CUPROUS CHLORIDE IN ETHYL ALCOHOL CONTAINING INCREASING AMOUNTS OF HYDROCHLORIC ACID AT 25° (Kiang-Su Chang and Yeu Ming Liu, 1934)

Gm. Equiv. per 1000 gms. C ₂ H ₅ OH		Gm. Equiv. per 1000 gms. C ₂ H ₅ OH	
HCl	CuCl	HCl	CuCl
0.07839	0.06078	0.4356	0.3660
0.1524	0.1281	0.4676	0.4035
0.2775	0.2336	0.5368	0.4663
0.3223	0.2766	0.6108	0.5230
0.3953	0.3338	0.6479	0.5538
0.4303	0.3660	0.7254	0.6299

SOLUBILITY OF CUPROUS CHLORIDE IN DIOXANE (Heines and Yntema, 1938)

About 5 gms. CuCl were allowed to stand in contact with 25 cc of Anhydrous Dioxane at 26.5° for two weeks. After that time the solution contained 0.031 gms. CuCl per 100 ml. of saturated solution.

SOLUBILITY OF CUPROUS CHLORIDE IN ACETONITRILE

t°	Gms. per 100 gms. sat. sol.	Author
18	11.76	(Natmann and Schier, 1914)
25	8.	(Pleskov, 1948)

Cl CUPROUS Tetrapyridine CHLORIDE [Cu₂(C₅H₅N)₄]Cl₂

SOLUBILITY IN WATER (Markuhyan, 1940)

t°	25	30	35	40	45	50	55	60	65	70
Gms. [Cu ₂ (C ₅ H ₅ N) ₄]Cl ₂ per 100 ml. H ₂ O	0.2	0.25	0.3	0.31	0.315	0.317	0.33	0.35	0.38	0.39

Melting point data are given for:

CuCl + CuCl ₂	(Biltz and Fischer, 1927; Fontana, Gorin, Kidder and Meredith, 1952)
" + FeCl ₃	(Hermann, 1911)
" + PbCl ₂	(Pelabon and Lande, 1928)
" + LiCl	(Sandonnini, 1911, 1914; Korreng, 1914)
" + RbCl	(Sandonnini, 1914; Sandonnini and Aureggi, 1912)
" + AgCl	(Sandonnini, 1911, 1914; Poma and Gabbi, 1911, 1912)
" + KCl	(Sandonnini, 1911, 1914; Korreng, 1914; Sackur, 1913; Poma and Gabbi, 1911, 1912; Fontana, Gorin, Kidder and Meredith, 1952)
" + NaCl	(Sandonnini, 1911, 1914; Korreng, 1914; Sackur, 1913; de Cesari, 1911)
" + TiCl	(Sandonnini, 1911, 1914)
" + SnCl ₂	(Hermann, 1911)
" + ZnCl ₂	(" ")
" + HgCl	(Janecke, 1923)
" + CuCl ₂ + KCl	(Fontana, Gorin, Kidder and Meredith, 1952)
" + Cu ₂ S	(Truthe, 1912)
" + Cu ₂ O	(" ")

CUPRIC CHLORIDE CuCl₂

Cl

SOLUBILITY IN WATER

The numerous determinations of Boye (1933) are in agreement with those of other workers, but no one else has found any hydrate other than CuCl₂·2H₂O. (Boye reports .4, .3 and .1 hydrates) Benrath (1934a) points out that Boye allowed only 1/2 to 1 hour for equilibrium. On the basis of thermal analysis, Kamecki and Trau (1955) conclude that only the dihydrate is stable from 2° to 131°. Boye's transition temperatures are: ICE + .4H₂O(-43.4°), .4 + .3 H₂O(+15.0°), .3 + .2H₂O(25.7°), .2 + .1H₂O(42.2°). The data are those of Boye unless otherwise noted.

t°	Gms. per 100 gms. sat. sol.	Solid Phase
- 2.9	7.8	Ice
- 4.5	11.3	"
-10.0	17.5	"
-18.1	25.4	"
-31.4	34.1	"
-37.5	37.5	"
-43.4 (Eutec.)	39.9	" + CuCl ₂ ·2H ₂ O
-29.9	39.4	CuCl ₂ ·2H ₂ O
-26.8	39.4	"
0.0	40.7*	"
	(40.41) ¹	"
	(40.92) ²	"
	(40.85) ³	"

*Density of solution saturated at 0° = 1.511, at 17.5° = 1.579.

¹Engel, 1889

²Foot, 1923

³Benrath, 1932a

(Cont.)

Cu CUPRUM

	t°	Gms. per 100 gms. sat. sol.	Solid Phase
	+ 10.0	41.5	CuCl ₂ ·2H ₂ O
	15.0	42.1	"
	19.0	42.1	"
		(42.67) ³	"
	21.6	42.3	"
	23.0	42.6	"
	24.9	43.3	"
	25	(43.32) ²	"
		(43.60) ⁴	"
		(44.62) ⁵	"
Cl	25.7	43.6	"
	28.5	43.6	"
	30	(43.4) ⁶	"
		(43.9) ⁷	"
		(43.95) ^{8,10}	"
	31.0	43.6	"
	35	(44.47) ⁹	"
	35.8	43.9	"
	39.9	44.7	"
	42.2	45.2	"
	45.3	45.0	"
	50.0	45.0	"
		(46.05) ³	"
	54	(47.24) ⁴	"
	61.2	46.7	"
	68.3	47.8	"
	75	(50.40) ⁴	"
	75.1	48.7	"
	82.0	49.8	"
	89.9	50.9	"
	96.1	52.0	"
	99	(53.66) ³	"
	100	(54.60) ⁴	"
	101.8	52.8	"
	112	(56.66) ⁴	"
	116.8 b. pt.	55.0	"
	(115.4 b. pt.)	(¹¹)	

²Foote, 1923

³Benrath, 1932a

⁴Chretien and Weil, 1935

⁵Blidin and Gorienko, 1954

⁶Schreinemakers and Noorduy, 1918

⁷Meerberg, 1905

⁸Schreinemakers and de Baat, 1908-9

⁹Schreinemakers and Thonus, 1912

¹⁰Schreinemakers, 1910

¹¹Kamecki and Trau, 1955

SOLUBILITY OF CUPRIC CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 0°

(in agreement)

(Foote, 1923)			(Engel, 1889)		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Density
CuCl ₂	HCl		CuCl ₂	HCl	
40.92	0.0	CuCl ₂ ·2H ₂ O	41.41	0.0	1.490
34.82	3.72	"	39.58	1.11	1.475
23.82	10.35	"	38.37	1.95	1.458
15.64	16.71	"	37.19	2.67	1.435
12.12	21.82	"	33.11	5.31	1.389
13.86	29.02	"	25.50	10.37	1.319
17.42	31.16	" + HCl·CuCl ₂ ·3H ₂ O	12.46	20.80	1.231
15.66	32.66	HCl·CuCl ₂ ·3H ₂ O	12.27	29.00	1.288
12.29	36.82	"	13.57	35.26	1.323
11.85	37.19	"			

Cl

Results at 25°

(Foote, 1923)

Results at 80°

(Morozov and Ustavshikova, 1945)

Gms. per 100 gms. sat. sol.		Solid Phase	(Read from the curve drawn by the authors)	
CuCl ₂	HCl		Gms. per 100 gms. sat. sol.	
43.32	0.0	CuCl ₂ ·2H ₂ O	CuCl ₂	HCl
32.85	6.52	"	44	5
23.74	12.95	"	38	10
18.34	18.08	"	35	15
17.01	22.26	"		
18.20	25.07	"		
22.65	27.76	"		
24.07	28.05	"		
25.65	28.49	"		

EQUILIBRIUM IN THE BASIC REGION OF THE SYSTEM COPPER OXIDE,
HYDROCHLORIC ACID AND WATER AT 25°
(Britton, 1925)

The saturated solutions were prepared from moist hydrated copper oxide, moist basic cupric chloride, hydrochloric acid and cupric chloride solution. Equilibrium was attained in about a week, but final analyses of the solutions and air dried solid phases were made only after three months. The terms in which the results are expressed are not clearly defined.

Liquid phases

Liquid phases

% CuO % HCl		Solid Phase	% CuO % HCl		Solid Phase
0.0	0.0	4CuO·2HCl·3H ₂ O + CuO (hydrate)	15.22	13.96	4CuO·2HCl·3H ₂ O
0.16	0.15	4CuO·2HCl·3H ₂ O	18.52	17.03	"
3.90	3.57	"	21.24	19.49	"
8.35	7.66	"	25.59	23.51	" + CuCl·2H ₂ O

Cu CUPRUM

$\text{CuCl}_2 \cdot 3\text{CuO} \cdot 4\text{H}_2\text{O}$ (Atacamite) was shaken with distilled water containing varying amounts of Carbon Dioxide at 20°.

Gms. CO_2 per liter: 0 0.38 0.90
Mg. Cu per liter: 0.8 50.3 91.0 (Archipov and Paksver, 1939)

The solubility product was determined by Nasanen (1942a)

The solubility product at 25° in Potassium Chloride Solutions was determined by Nasanen and Tamminen, 1949.

Cl

SOLUBILITY OF CuCl_2 IN AQUEOUS AMMONIA AT 20° (Archipov and Paksver, 1939)

A 21% NH_3 solution of CuCl_2 contains 142.0 gms. Cu per liter.

THE SYSTEM CUPRIC CHLORIDE - MERCURIC CHLORIDE - WATER (Data of Bassett, Barton, Foster and Pateman, 1933)

Results at 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HgCl_2	CuCl_2		HgCl_2	CuCl_2	
0.0	43.32	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	0.0	44.47	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
48.75	22.53	"	49.71	22.50	"
51.68	21.46	" + HgCl_2	52.13	21.69	" + HgCl_2
51.50	21.35	HgCl_2	52.35	21.09	HgCl_2
51.57	20.95	"	52.60	20.27	"
51.83	20.64	"	53.28	18.70	"
52.89	18.86	"	52.36	14.51	"
51.47	14.86	"	8.51	0.0	"
6.90	0.0	"			

Results at 35°

(Data of Schreinemakers and Thonus, 1912)

Results at 35°

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
HgCl_2	CuCl_2		HgCl_2	CuCl_2	
0	44.47	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	52.54	18.46	HgCl_2
21.03	33.5	"	52.81	18.06	"
37.30	26.07	"	51.03	14.73	"
44.47	23.31	"	49.50	5.94	"
50.47	21.50	" + HgCl_2	23.87	2.64	"
52.44	19.40	HgCl_2	8.51	0	

EQUILIBRIUM IN THE SYSTEM CUPRIC CHLORIDE, POTASSIUM
CHLORIDE AND WATER AT VARIOUS TEMPERATURES
(Chretien and Weil, 1936)

For additional data see Meyerhoffer, 1890.

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		KCl	CuCl ₂	
-65.0	-	0.20	39.9	Ice + 1.2.2 + CuCl ₂ ·2H ₂ O
-63.2	-	0.70	36.5	Ice + 1.1.2 + 1.2.2
-30.0	-	0.93	39.74	1.1.2 + CuCl ₂ ·2H ₂ O
"	-	1.67	36.51	1.1.2 + 1.2.2
-21.0	-	8.0	21.40	Ice + KCl + 1.1.2
-18	-	9.04	21.10	Ice + KCl
0	-	3.35	40.97	1.1.2 + CuCl ₂ ·2H ₂ O
"	1.537	3.68	40.17	1.1.2
"	1.509	4.88	38.23	1.1.2 + 1.2.2
"	1.478	5.19	35.96	1.2.2
"	- 1	8.32	28.48	"
"	1.340	13.22	21.07	"
"	1.338	13.92	20.15	" + KCl
"	1.251	15.26	13.11	KCl
"	-	18.26	6.14	"
"	-	21.85	0.0	"
20	1.578	5.90	42.45	1.1.2 + CuCl ₂ ·2H ₂ O
"	-	7.70	39.88	1.1.2 + 1.2.2
"	1.370	17.98	21.06	1.2.2 + KCl
25	-	0.0	43.60	CuCl ₂ ·2H ₂ O
"	1.558	2.94	43.45	"
"	1.581	5.49	43.25	"
"	1.593	6.27	43.16	"
"	1.594	6.46	43.15	" + 1.1.2
"	1.589	6.75	42.76	1.1.2
"	1.583	7.50	41.59	"
"	1.573	7.94	41.27	"
"	1.567	8.37	40.43	" + 1.2.2
"	1.541	9.23	38.40	1.2.2
"	1.475	11.37	33.10	"
"	-	14.84	27.90	"
"	-	17.77	23.24	"
"	1.350	19.03	21.30	" + KCl
"	1.127	21.80	11.21	KCl
"	1.190	24.01	5.47	"
"	-	26.40	0.0	"
35	-	8.15	44.10	1.2.2 + CuCl ₂ ·2H ₂ O
"	-	10.33	41.57	1.2.2 + 1.1.2
"	-	21.06	22.56	1.2.2 + KCl
50	-	11.55	45.67	1.2.2 + CuCl ₂ ·2H ₂ O
"	-	14.00	42.92	1.2.2 + 1.1.2
"	-	25.36	26.97	1.2.2 + KCl
54	-	-	47.24	CuCl ₂ ·2H ₂ O
54.4	-	12.4	46.3	" + 1.1.2

1.1. = CuCl₂·KCl; 1.1.2 = CuCl₂·KCl·2H₂O; 1.2.2 = CuCl₂·2KCl·2H₂O.

(Cont.)

Cu CUPRUM

EQUILIBRIUM IN THE SYSTEM CUPRIC CHLORIDE, POTASSIUM CHLORIDE AND WATER AT VARIOUS TEMPERATURES--Contd.

t°	d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
		KCl	CuCl ₂	
56.0	-	13.55	45.73	M.C. + 1.1.2
58	-	12.36	46.61	CuCl ₂ ·2H ₂ O
"	-	12.82	46.85	" + M.C.
"	-	14.36	45.64	M.C.
"	-	14.94	45.00	" + 1.1.2
"	-	15.47	44.40	1.1.2
C1 58.4	-	15.6	44.4	" + M.C. + 1.1
59.0	-	12.95	46.81	M.C.
"	-	14.42	45.46	"
"	-	14.85	45.20	" + 1.1
"	-	15.56	44.53	1.1
59.2	-	16.0	44.2	" + 1.1.2 + 1.2.2
60.0	-	13.0	47.1	" + M.C. + CuCl ₂ ·2H ₂ O
"	-	16.18	44.14	1.2.2 + 1.1
61.0	-	12.93	47.13	1.1 + CuCl ₂ ·2H ₂ O
75.0	-	0.0	50.40	CuCl ₂ ·2H ₂ O
"	1.711	5.74	49.88	"
"	1.787	12.45	49.30	" + 1.1
"	1.781	15.35	46.70	1.1
"	-	18.44	44.11	"
"	1.761	20.27	42.73	"
"	1.756	21.95	41.42	" + 1.2.2
"	1.716	25.16	35.75	1.2.2
"	1.629	28.33	31.56	" + KCl
"	1.499	28.13	23.74	KCl
"	1.360	29.79	12.63	"
"	-	33.20	0.0	"
88	-	29.74	38.03	1.1 + 1.2.2
"	-	30.32	36.22	1.2.2 + KCl
93.2	-	31.2	37.5	" + " + 1.1
100	-	0.0	54.6	CuCl ₂ ·2H ₂ O
"	1.690	5.53	53.69	"
"	1.853	11.53	53.26	" + 1.1
"	1.815	13.14	51.30	1.1
"	1.771	25.42	41.80	"
"	1.783	31.69	38.21	"
"	1.700	33.29	37.51	" + KCl
"	1.651	32.20	31.11	KCl
"	-	35.70	0.0	"
108.6(b. pt.)	-	36.80	0.0	"
112	-	0.0	56.66	CuCl ₂ ·2H ₂ O
115.8(b. pt.)	-	0.0	57.90	"
116	-	35.21	38.17	1.1 + KCl
"	-	10.10	56.02	" + CuCl ₂ ·2H ₂ O
119.9	-	35.50	38.40	" + KCl
121.5(b. pt.)	-	9.90	58.15	" + CuCl ₂ ·2H ₂ O

1.1 = CuCl₂·KCl; 1.1.2 = CuCl₂·KCl·2H₂O; 1.2.2 = CuCl₂·2KCl·2H₂O;
M.C. = Mixed Crystals.

THE SYSTEM CUPRIC CHLORIDE - LITHIUM CHLORIDE - WATER

(Schreinemakers, and Noorduyn, 1918 (30°); Blidin and Gordienko, 1954 (25°); all other temperatures: Benrath, 1932a)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.				
t°	CuCl ₂	LiCl	Solid Phase	t°	CuCl ₂	LiCl	Solid Phase
0	40.85	0.0	CuCl ₂ ·2H ₂ O	30	20.7	19.0	CuCl ₂ ·2H ₂ O
"	32.33	5.78	"	"	19.6	26.2	CuCl ₂ ·2H ₂ O + 1.1.2
"	18.97	15.69	"	"	16.2	28.6	1.1.2
"	11.22	29.55	" + 1.1.2	"	13.6	29.7	"
"	9.14	31.10	1.1.2	"	7.3	36.3	"
"	3.92	36.03	"	"	4.4	40.3	"
"	2.08	38.77	" + LiCl·2H ₂ O	"	2.7	42.8	"
"	0.0	40.51	LiCl·2H ₂ O	"	1.8	45.4	" + LiCl·H ₂ O
16	15.46	27.84	CuCl ₂ ·2H ₂ O + 1.1.2	"	1.7	45.5	LiCl·H ₂ O
"	1.42	43.45	LiCl·2H ₂ O + 1.1.2	"	0.0	46.3	"
19	42.67	0.0	CuCl ₂ ·2H ₂ O	40	22.69	25.03	CuCl ₂ ·2H ₂ O + 1.1.2
"	33.46	6.44	"	"	2.41	45.70	LiCl·2H ₂ O + 1.1.2
"	21.32	16.08	"	50	46.05	0.0	CuCl ₂ ·2H ₂ O
"	18.78	18.59	"	"	37.39	6.65	"
"	16.06	27.58	" + 1.1.2	"	26.97	16.69	"
"	11.29	31.15	1.1.2	"	25.17	21.49	"
"	1.39	44.22	" + LiCl·2H ₂ O	"	25.54	24.20	" + 1.1.2
"	0.90	44.55	LiCl·2H ₂ O	"	25.65	24.80	1.1.2
25	44.62	0.0	CuCl ₂ ·2H ₂ O	"	8.98	37.43	"
"	36.21	4.53	"	"	6.68	40.21	"
"	32.34	6.25	"	"	3.22	46.01	"
"	24.16	15.02	"	"	3.06	46.51	" + LiCl·H ₂ O
"	19.35	21.47	" + 1.1.2	"	1.09	47.50	LiCl·H ₂ O
"	18.53	22.94	1.1.2	"	0.0	48.18	"
"	16.20	26.18	"	75	33.13	21.67	CuCl ₂ ·2H ₂ O + 1.1.2
"	12.14	31.86	"	"	5.39	43.81	LiCl·H ₂ O + 1.1.2
"	7.57	38.15	"	99	53.66	0.0	CuCl ₂ ·2H ₂ O
"	5.60	42.51	" + LiCl·H ₂ O	"	47.88	5.04	"
"	4.50	43.44	" + "	"	40.62	12.60	"
"	3.54	44.31	" + "	"	39.59	14.51	"
"	1.50	45.20	LiCl·H ₂ O	"	40.31	16.16	"
"	0.0	45.95	"	"	42.03	18.30	" + 1.1.2
30	43.4	0.0	CuCl ₂ ·2H ₂ O	"	31.13	25.82	1.1.2
"	40.2	2.5	"	"	27.78	27.80	"
"	39.5	2.9	"	"	12.23	45.38	"
"	35.5	5.7	"	"	10.61	46.91	"
"	34.9	6.2	"	"	9.18	49.77	" + LiCl
"	27.9	11.8	"	"	8.78	50.06	LiCl
"	24.2	13.8	"	"	7.69	50.68	"
"	22.7	16.3	"	"	0.0	55.84	"

Cl

Cu CUPRUM

THE SYSTEM CUPRIC CHLORIDE - AMMONIUM CHLORIDE - WATER

Data of Rivett and Clendinning, 1923

Results at $0.2^{\circ} \pm 0.1^{\circ}$

d_{25}^4 of sat. sol.	Gms. per 100 gms. sat. sol.		Gms. per 100 gms. undissolved residue	
	NH_4Cl	CuCl_2	NH_4Cl	CuCl_2
C1 1.078	22.59	0.91	82.4	2.29
1.084	22.28	1.62	41.8	38.6
1.117	13.69	7.57	34.8	42.2
1.178	7.49	15.09	34.9	44.6
1.273	2.95	24.46	32.1	44.6
1.392	1.19	33.86	26.8	45.3
1.495	0.76	41.7	1.70	48.9
1.498	0.75	40.8	0.49	52.1

Results at $25^{\circ} \pm 0.1^{\circ}$

1.086	28.02	0.995	73.3	1.51
1.092	27.69	1.78	45.6	24.9
1.093	26.86	2.05	36.1	38.1
1.114	19.59	6.41	34.9	40.0
1.145	15.26	19.96	34.0	40.8
1.191	10.94	16.35	28.9	37.2
1.263	6.53	23.76	27.5	40.2
1.378	3.16	33.2	27.6	44.7
1.524	1.82	43.3	8.08	53.2
-	1.79	43.3	13.64	51.5
1.523	1.44	43.2	0.88	57.2

These results show that the supposed compound $2\text{NH}_4\text{Cl} \cdot \text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ exists only in a very narrow region of the mixed crystals.

Additional determinations for the ammonium end of this system at 25° are given by Foote, 1912.

Data of Meerburg, 1905 at 30°

Grams per 100 Gms. Sat. Solution		Grams per 100 Gms. Solid Phase		Solid Phase
CuCl_2	NH_4Cl	CuCl_2	NH_4Cl	
0	29.5	...	...	\text{NH_4Cl
1.9	28.6	6.0	48.2	$\text{NH}_4\text{Cl} + \text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
3.6	25.9	37.0	34.9	$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
10.5	16.5	21.7	23.1	"
19.9	9.4	28.5	18.4	"
29.4	4.9	35.1	15.3	"
41.4	2.1	43.1	13.3	"
43.2	2.0	51.9	6.6	$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O} + \text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
43.9	0	...		$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$

(Cont.)

Data of Morozov and Ustavshikova, 1945 at 80°

The authors present a diagram of the system, and the following invariant solutions compositions:

Gms. CuCl_2 per 100 gms. Sat. Sol.	Gms. NH_4Cl per 100 Gms. Sat. Sol.	Solid Phases
7.06	37.64	$\text{NH}_4\text{Cl} + \text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
50.5	8.2	$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O} + \text{CuCl}_2 \cdot 2\text{H}_2\text{O}$

COPPER AMMONIUM CHLORIDE $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$

Cl

SOLUBILITY IN WATER (Meerburg, 1905)

t°	Gms. $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl}$ per 100 Gms. Solution	Solid Phase
-10.5	3.87	Ice
-10.8	20.12	"
-11	20.3	Ice + $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
-10	20.46	$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
0	22.02	"
12	24.26	"
20	25.95	"
30	27.70	"
40	30.47	"
50	33.24	"
60	36.13	"
70	39.35	"
80	43.36	"

The system $\text{CuCl}_2 + \text{NH}_4\text{Cl} + \text{HCl} + \text{H}_2\text{O}$ was studied by Morozov and Ustavshikova, 1945 at 25° and 80°, and their data is presented in the form of 3 dimensional graphs. The compositions of the invariant solutions are tabulated, and the compound $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$ was found at both temperatures.

THE SYSTEM CUPRIC CHLORIDE - SODIUM CHLORIDE - WATER

Results at 19°
(Fedotieff, 1926)

Gms. per 1000 cc sat. solution		Solid Phase	Gms. per 1000 cc sat. solution		Solid Phase
NaCl	CuCl_2		NaCl	CuCl_2	
9.3	1.2	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	243.2	129.0	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
47.2	5.4	"	369.8	298.3	" + NaCl
80.2	12.3	"	361.5	245.8	NaCl
123.1	29.2	"	329.0	50.4	"
170.7	54.4	"	317.0	0.0	"

(Cont.) See note, next page.

Cu CUPRUM

The solutions were saturated in an atmosphere of carbon dioxide. The sodium chloride solutions were acidified with several drops of hydrochloric acid. (Fedotieff)

Results at 30°

(Schreinemakers and de Baat, 1908-09)

	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	NaCl	CuCl ₂		NaCl	CuCl ₂	
Cl	0	43.95	CuCl ₂ ·2H ₂ O	12.25	32.40	NaCl
	3.10	41.14	"	13.54	28.64	"
	4.28	41.06	"	15.40	23.72	"
	6.41	39.40	"	18.44	16.98	"
	10.25	36.86	" + NaCl	20.61	11.03	"
	12.02	32.38	NaCl	26.47	0	"

Solubility of CuCl₂ in Aq. NaCl at Several Temperatures (Hunt, 1870)

Gms. CuCl₂ per 100 cc Solution of:

t°	Sat. NaCl	15% NaCl	5% NaCl
11	8.9	3.6	...
40	11.9	6	1.1
90	16.9	10.3	2.6

DISTRIBUTION OF CUPRIC CHLORIDE BETWEEN Aq. HCl AND ETHER

When 1 gm. of copper as chloride is dissolved in 100 cc of 10% HCl and shaken with 100 cc of ether, 0.05% of the metal enters the ethereal layer. (Mylius, 1911)

100 cc of a mixture of equal volumes of Diethyl Ether and Water, saturated with HCl at 0° will dissolve 6.4 gms. of CuCl₂. (Fischer and Seidel, 1941)

SOLUBILITY OF ANHYDROUS CUPRIC CHLORIDE IN ALCOHOLS (Lloyd, Brown, Glynwyn, Bonnell and Jones, 1928)

Results for Methyl Alcohol			Results for Ethyl Alcohol		
t°	Gms. CuCl ₂ per 100 gms. CH ₃ OH	Solid Phase	t°	Gms. CuCl ₂ per 100 gms. C ₂ H ₅ OH	Solid Phase
0	56.5	CuCl ₂ ·2CH ₃ OH	0	42.3	CuCl ₂ ·2C ₂ H ₅ OH
10	57.4	"	10	46.0	"
20	58.6	"	20	50.0	"
30	60.0	"	25	51.0*	"
40	61.8	"	30	54.1	"
50	64.4	"	40	58.3	"
60	66.4	"	50	63.9	"
			60	70.8	"

*Partington and Soper, 1929.

SOLUBILITY OF ANHYDROUS CUPRIC CHLORIDE IN ALCOHOLS--Contd.

Results for n Propyl Alcohol		Results for iso Amyl Alcohol		Results for Benzyl Alcohol	
t°	Gms. CuCl_2 per 100 gms. n $\text{C}_3\text{H}_7\text{OH}$ *	t°	Gms. CuCl_2 per 100 gms. iso $\text{C}_5\text{H}_{11}\text{OH}$	t°	Gms. CuCl_2 per 100 gms. $\text{C}_6\text{H}_5\cdot\text{CH}_2\cdot\text{CH}$
10	20.0	10	10.7	10	1.40
20	24.7	20	12.1	20	1.65
30	29.4	30	14.2	30	2.14
40	34.2	40	16.2	40	3.02
50	37.7	50	21.0	50	4.40
60	41.1	60	25.2	60	6.12

Cl

*Solid phase anhydrous

Results in various alcohols are also given by Etard, 1894; de Bruyn, 1892; de Coninck 1900 and St. von Laszczynski, 1894. Except for methanol, the data do not agree with the above. These authors give the following results for other alcohols:

Solvent	Gms. CuCl_2 per 100 gms. sat. sol.			
	0°	20°	40°	80°
Iso Propyl Alcohol	...	...	16.0	30.0
n Butyl Alcohol	15	15.3	16.0	16.5
Allyl Alcohol	23	23.0	...	...

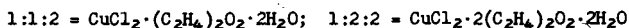
SOLUBILITY OF CUPRIC CHLORIDE IN PYRIDINE
(Mathews and Spero, 1917)

t°	Gms. CuCl_2 per 100 Gms.	Solid Phase	t°	Gms. CuCl_2 per 100 Gms.	Solid Phase
	Sat. Sol.			Sat. Sol.	
-17.3	0.140	$\text{CuCl}_2 \cdot 6\text{C}_5\text{H}_5\text{N}$	45	0.422	$\text{CuCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$
-12.1	0.195	"	53	0.493	"
-10	0.295	" (unstable)	60	0.565	" (unstable)
- 8.9	0.270	" + $\text{CuCl}_2 \cdot \text{C}_5\text{H}_5\text{N}$	62	0.616	" "
+ 2	0.275	$\text{CuCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$	58	...	" + $2\text{CuCl}_2 \cdot 3\text{C}_5\text{H}_5\text{N}$
10	0.293	"	63	0.543	$2\text{CuCl}_2 \cdot 3\text{C}_5\text{H}_5\text{N}$
25	0.348	"	75	0.631	"
35	0.382	"	95	0.917	"

Cu CUPRUM

THE SYSTEM CUPRIC CHLORIDE - DIOXANE - WATER AT 25°
(Weicksel and Lynch, 1950)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CuCl ₂	Dioxane		CuCl ₂	Dioxane	
Cl	43.10	0.75	CuCl ₂ ·2H ₂ O	9.44	47.82	1:2:2
	39.77	3.62	" + 1:1:2	6.93	38.66	"
	34.70	4.36	1:1:2	4.51	71.01	"
	25.48	7.13	"	3.01	79.27	"
	22.30	9.38	"	1.86	86.53	"
	18.80	15.49	"	0.86	92.90	"
	15.38	24.44	"	0.27	97.14	"
	12.48	35.08	"	0.0	99.34	" + CuCl ₂ ·(C ₂ H ₄) ₂ O ₂
	11.55	40.15	1:1:2 + 1:2:2			



SOLUBILITY IN DIOXANE AT 26.5°

Heines and Yntema, 1938 found the solubility to be 0.311 gms. CuCl₂ per 100 cc of saturated solution by allowing Anhydrous Dioxane to stand in contact with the solid for two weeks. The authors found a 1:2 and a 2:1 compound to be formed between the substances.

SOLUBILITY OF CUPRIC CHLORIDE IN ANHYDROUS ACETIC ACID
DETERMINED BY THE SYNTHETIC METHOD
(Davidson and Chappell, 1938)

t°	Gm. Mol. CuCl ₂ per 100 gm. mol. CuCl ₂ + CH ₃ COOH	Solid Phase
30	0.0070	CuCl ₂
35	0.0081	"
50	0.0150	"
62	0.0163	"
75	0.0218	"

THE SYSTEM CUPRIC CHLORIDE - ACETONE - WATER AT 30°
(Jacobs, 1914)

[see also the table p.947]

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Acetone	CuCl ₂		Acetone	CuCl ₂	
0.0	43.95	CuCl ₂ ·2H ₂ O	49.03	22.90	CuCl ₂ ·2H ₂ O
5.00	41.00	"	67.43	14.97	"
13.16	37.47	"	76.40	11.80	"
19.10	35.58	"	82.20	9.77	"
32.90	29.18	"	92.98	4.70	"
42.50	26.20	"	98.97	1.03	CuCl ₂ ·2CH ₃ COCH ₃

SOLUBILITY OF CUPRIC CHLORIDE IN OTHER SOLVENTS

(Etard, 1894; Naumann and Schier, 1914; Naumann, 1904; Welsh and Brodersen, 1915; see also de Coninck, 1900; St. von Laszczynski, 1894)

Solvent	t°	Gms. CuCl_2 per 100 gms. sat. sol.
Ethyl formate	0	10
	20	9
	40	8
Ethyl acetate	18	1.57 ^a (N.)
	20	3.0 (E.)
	40	2.5 (E.)
	72	1.3 (E.)
Methyl acetate	18	0.55 ^b (N.)
Anhyd. Hydrazine	ord.	5 (decomp.)(W. & B.)
Acetone (abs.)†	0	8.86*
	15	8.92*
	18	2.88
	56	1.40
Acetone (80%) †	23	18.9 *
Acetonitrile	18	1.57 (N. & S.)
Ether	11	0.43
	20	0.11

^adensity = 0.9055

^bdensity = 0.939

*gms. $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ dissolved

†See also table p. 946

For the solubility of cupric chloride in mixtures of a number of organic solvents, see de Coninck, 1900.

COPPER POTASSIUM CHLORIDE $\text{CuCl}_2 \cdot \text{KCl}$

Cl

SOLUBILITY IN ABSOLUTE ALCOHOL AND IN ACETONE AT 25°
(Foote and Walden, 1911)

In Absolute Alcohol			In Acetone		
Gms. per 100 gms. Sat. Sol.		Solid Phase	Gms. per 100 gms. Sat. Sol.		Solid Phase
CuCl_2	KCl		CuCl_2	KCl	
1.40	0.28	$\text{KCl} + \text{CuCl}_2 \cdot \text{KCl}$	0.34	0.38	$\text{KCl} + \text{CuCl}_2 \cdot \text{KCl}$
2.15	not det.	$\text{CuCl}_2 \cdot \text{KCl}$	0.48	not det.	$\text{CuCl}_2 \cdot \text{KCl}$
5.25	"	"	1.50	"	"
30.16	"	"	2.06	"	"
34.45	0.21	" + $\text{CuCl}_2 \cdot \text{C}_2\text{H}_5\text{OH}$	2.40	0.27	" + $\text{CuCl}_2 \cdot \text{C}_3\text{H}_7\text{OH}$
33.97	0	$\text{CuCl}_2 \cdot \text{C}_2\text{H}_5\text{OH}$			

Cu CUPRUM

CI COPPER AMMONIUM CHLORIDE $\text{CuCl}_2 \cdot \text{NH}_4\text{Cl}$

SOLUBILITY IN ABSOLUTE ALCOHOL AT 25°
(Foote and Walden, 1911)

Gms. per 100 Gms. Sat. Sol.		Solid Phase
CuCl_2	NH_4Cl	
4.7	not det.	$\text{NH}_4\text{Cl} + \text{CuCl}_2 \cdot \text{NH}_4\text{Cl}$
6.45	"	$\text{CuCl}_2 \cdot \text{NH}_4\text{Cl}$
12.90	"	"
34.7	"	" + $\text{CuCl}_2 \cdot \text{C}_2\text{H}_5\text{OH}$

COPPER Choline CHLORIDE $(\text{CH}_3)_2\text{HCIC}_2\text{H}_4\text{OH} \cdot \text{CuCl}_2$

0.1 gms. are dissolved in 100 ml. of solution in water at room temperature. (Seaman, Huganet, and Leibmann, 1949)

Melting point data are given for the System $\text{CuCl}_2 + \text{KCl}$ by Fontana, Gorin, Kidder and Meredith, 1952.

CI0 COPPER CHLORATE $\text{Cu}(\text{ClO}_3)_2$

SOLUBILITY IN WATER
(Meusser, 1902)

t°	Gms. $\text{Cu}(\text{ClO}_3)_2$ per 100 Gms. Solution	Mols. $\text{Cu}(\text{ClO}_3)_2$ per 100 Mols. H_2O	Solid Phase
-12	30.53	3.43	Ice
-31	54.59	9.39	$\text{Cu}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$
-21	57.12	10.41	"
+ 0.8	58.51	11.02	"
18	62.17	12.84	"
45	66.17	15.28	"
59.6	69.42	17.73	"
71	76.9	25.57	"

Density of solution saturated at 18° = 1.695.

COPPER PERCHLORATE $\text{Cu}(\text{ClO}_4)_2$

ClO

SOLUBILITY IN WATER

t°	Gms. $\text{Cu}(\text{ClO}_4)_2$ per 100 gms. sat. sol.	Solid Phase	Author
0	54.3	$\text{Cu}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$	(Portillo and Alberola, 1930)
30	59.3	"	(Craven and Bryce, 1934)

THE SYSTEM COPPER PERCHLORATE - AMMONIUM PERCHLORATE - WATER AT 30°
(Craven and Bryce, 1934)

Gms. per 100 gms. H_2O		Solid Phase	Gms. per 100 gms. H_2O		Solid Phase
NH_4ClO_4	$\text{Cu}(\text{ClO}_4)_2$		NH_4ClO_4	$\text{Cu}(\text{ClO}_4)_2$	
0.0	141.6	$\text{Cu}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$	11.42	30.00	NH_4ClO_4
2.075	141.0	" + NH_4ClO_4	14.28	22.51	"
3.059	90.93	NH_4ClO_4	17.99	14.89	"
5.322	58.12	"	28.00	0.0	"
10.13	34.04				

100 cc Furfural, $\text{C}_4\text{H}_3\text{OCHO}$, $d_4^{25} = 1.1550$ dissolve about 80 gms. $\text{Cu}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$ at about 20°.

100 cc Furfural, $\text{C}_4\text{H}_3\text{OCHO}$, $d_4^{25} = 1.1550$ dissolve about 20+ gms. $\text{Cu}(\text{ClO}_4)_2 \cdot 2\text{H}_2\text{O}$ at about 20°.

100 cc Cellosolve (mono ethyl ether of ethylene glycol) dissolve about 100+ gms. $\text{Cu}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$ at about 20°.

CUPRIC Hexahydroxy PERCHLORATE

The solubility product at 25° in sodium perchlorate solutions was determined by Nasanen and Tamminen, 1949.

COPPER CHROMATE CuCrO_4

CrO

EQUILIBRIUM IN THE SYSTEM COPPER OXIDE - CHROMIC OXIDE - WATER AT 29.9°
(Campbell and Lemaire, 1947)

Five solid phases were found in the system. The normal Chromate CuCrO_4 is partially metastable with respect to the compound $\text{CuCrO}_4 \cdot \text{Cu}(\text{OH})_2$, but the extent of the metastability was not determined.

(Cont.)

Cu CUPRUM

CrO	Gms. CuO per 100 gms. Sat. Sol.	Gms. CrO ₃ per 100 gms. Sat. Sol.	Solid Phase
	0.0	64.8	CrO ₃
	1.0	64.4	"
	5.7	62.1	"
	10.9	60.6	"
	12.6	61.0	"
	13.2	61.8	CuCr ₂ O ₇ ·2H ₂ O + CrO ₃
	13.1	61.7	"
	13.8	60.7	CuCr ₂ O ₇ ·2H ₂ O
	14.6	58.6	"
	15.0	54.7	"
	14.5	53.1	CuCrO ₄
	15.1	47.4	"
	15.4	46.9	"
	15.0	40.5	"
	12.7	31.9	"
	10.1	25.4	"
	8.80	22.3	"
	7.94	19.6	"
	6.60	16.6	"
	5.80	14.8	"
	4.31	11.3	"
	6.80	10.5	CuCrO ₄ ·Cu(OH) ₂
	5.70	8.53	"
	4.74	7.32	2CuCrO ₄ ·3Cu(OH) ₂ ·H ₂ O
	2.42	5.89	"

Peterson and Cooper, 1951 report the solubility of CuCrO₄ in water at 25° to be 0.00344 Molar. The thermodynamic solubility product is 3.6×10^{-6} .

F CUPRIC FLUORIDE CuF₂·2H₂O

100 cc sat. sol. of Copper Fluoride in water contain 0.075 gm. CuF₂ at 25°. (Carter, 1928)

SOLUBILITY OF COPPER FLUORIDE IN AQUEOUS SOLUTIONS OF HYDROFLUORIC ACID AT 20° (Kurtenacker, Finger and Hey, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase
CuF ₂	HF	
7.4	6.6	CuF ₂ ·2H ₂ O
9.6	14.0	"
12.1	21.2	"
7.4	34.5	"

THE SYSTEM CUPRIC FLUORIDE - AMMONIUM FLUORIDE - WATER AT 20°
(Kurtenacker, Finger and Hey, 1933)

F

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuF ₂	NH ₄ F		CuF ₂	NH ₄ F	
2.15	2.2	CuF ₂ ·2H ₂ O	0.69	35.5	CuF ₂ ·2NH ₄ F·2H ₂ O
0.44	19.2	"	0.53	41.9	" + NH ₄ F
0.36	22.1	CuF ₂ ·2NH ₄ F·2H ₂ O	0.52	44.1	NH ₄ F
0.55	27.8	"			

THE SYSTEM CUPRIC FLUORIDE - POTASSIUM FLUORIDE - WATER AT 20°
(Kurtenacker, Finger and Hey, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuF ₂	KF		CuF ₂	KF	
1.5	1.2	Mixed crystals	-	22.9	Mixed Crystals
0.16	11.2	"	-	23.4	"
-	12.5	"			

SOLUBILITY OF CUPRIC FLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

t°	Gms. CuF ₂ per 100 gms. HF
-23.1	0.010 ± .004
- 8.3	0.008 ± .004
+12.4	0.010 ± .005

COPPER FLUOSILICATE CuSiF₆

SiF

THE SYSTEM COPPER FLUOSILICATE - WATER
(Pinaevskaya and Radosteva, 1953)

t°	Gms. per 100 gms. sat. sol.	Solid Phase	t°	Gms. per 100 gms. sat. sol.	Solid Phase
- 1.9	11.1	Ice	25	45.69	CuSiF ₆ ·4H ₂ O
- 5.4	18.0			(59.08)*	"
- 8.0	25.0		50	47.69	"
-12.5	30.0		75	48.25	"
-16.5	33.4		112.4	49.96	"
-25.3	39.3	" + CuSiF ₆ ·6H ₂ O	Metastable Data:		
0	42.36		0	42.73	CuSiF ₆ ·4H ₂ O
10	43.36		10	44.04	"
20	44.95		20	45.33	"
24	45.19		24	45.69	"

*Worthington and Haring, 1931.

BF COPPER Antipyrine FLUOBORATE $[\text{Cu}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_5](\text{BF}_4)_2$

CUPROUS IODIDE CuI

The solubility product of CuI in water is 5×10^{-12} . (Ruff, 1929)

The authors' table is headed "moles per 100 gms. H_2O ," but reasoning from the results with the silver halides, the units are probably moles per 1000 gms. H_2O .

t°	Moles CuI per 1000 gms. H ₂ O	t°	Moles CuI per 1000 gms. H ₂ O
180	0.000362	280	0.0040
200	.00065	300	.00495
220	.000830	320	.00624
240	.00132	340	.00899
260	.0029		

SOLUBILITY OF CUPROUS IODIDE IN AQUEOUS SOLUTIONS OF AMMONIUM
BROMIDE AND OF POTASSIUM BROMIDE
(Kohn, 1909; Kohn and Klein, 1912)

Results for Aq. NH_4Br at 20°			Results for Aq. KBr Solutions			
Normality NH_4Br Sol.	Gms. CuI per 1000 cc Sat. Sol.	t°	Normality of KBr Sol.	Gms. CuI per 1000 cc Sat. Sol.	Normality of KBr Sol.	Gms. CuI per 1000 Gms. Sat. Sol.
2	1.9068	19.5	2	1.467	23	3.595
3	3.6540	24	2	1.558	22	7.126
4	6.0588	19.5	3	3.409	22	6.977

SOLUBILITY OF CUPROUS IODIDE IN AQUEOUS SOLUTIONS OF IODINE
AT 20° AND VICE VERSA
(Fedotieff, 1910-11)

Constant agitation and temperature. Iodine determined by thiosulphate titration; copper, electrolytically.

Gms. per Liter		Solid Phase	Gms. per Liter		Solid Phase	Gms. per Liter		Solid Phase
Cu	I		Cu	I		Cu	I	
0.285	0.5848	CuI	0.964	5.0854	CuI	0.748	4.7112	I
0.482	1.3053	"	1.032	5.6854	"	0.606	3.8562	"
0.583	1.9218	"	1.090	6.2816	"	0.448	2.9493	"
0.678	2.5573	"	1.112	6.5301	"	0.300	2.0689	"
0.756	3.2042	"	1.232	7.6529	" + I	0.159	1.2304	"
0.844	3.9539	"	1.040	6.4440	I	(0° = 0.925	5.4609)	CuI + I
0.898	4.4359	"	0.898	5.5941	"	(40° = 1.658	11.3658)	"

Additional data for the solubility of cuprous iodide in aqueous solutions of iodine in presence of acids and salts at 25°, are given by Bray and MacKay (1910). These authors state that cuprous iodide is difficultly soluble in water, but in the presence of iodine a considerable amount dissolves, owing to the formation of cupric iodide and tri-iodide.

THE SYSTEM COPPER - IODINE - BENZENE AT 6°
(Foote and Fleischer, 1940)

The results indicate that CuI is the only stable compound formed by Copper and Iodine above 6°.

Wt. % Iodine in Solution	Wt. % Iodine in Residue	Solid Phase
0.0	55.00	Cu + CuI
3.05	65.99	CuI
7.79	66.20	"
8.53	69.40	CuI + I ₂
8.61	91.57	"

SOLUBILITY OF CuI IN ORGANIC SOLVENTS

100 gms. acetonitrile dissolve 3.52 gms. CuI at 18°. (Naumann and Schier, 1914)

100 cc pyridine dissolve 1.74 gm. CuI at 25°. (Muller, R., 1924)

COPPER PYRIDINE IODIDES

Data for the extraction of copper pyridine iodides (CuPyI₂ and CuPyI) by CHCl₃, CCl₄, (CH₂)Cl₂, C₆H₆ and 180 amyl alcohol are given by Tanaka, 1956.

Freezing-point lowering data for mixtures of CuI + AgI are given by Quercigh, 1914.

Cu CUPRUM

10 COPPER IODATE $\text{Cu}(\text{IO}_3)_2$

SOLUBILITY IN WATER AT 25°

Moles per liter Sat. Sol.	Gms. per liter Sat. Sol.	Author
0.00339	1.36	(Spencer, 1913)
.00369	1.527	(Peterson and Meyers, 1930)
.00325	1.304	(Keefer, 1948)
.00333 (Ave.)	1.336	(Monk, 1951; Lloyd, Wycherley and Monk, 1951)

SOLUBILITY OF CUPRIC IODATE IN AQUEOUS SOLUTIONS AT 25°
(Results of Keefer, 1948)

In Potassium Chloride Solutions		In Glycine Solutions		pH	In Alanine Solutions		pH
Moles per 1000 gms. H ₂ O		Moles per 1000 gms. H ₂ O			Moles per 1000 gms. H ₂ O		
KCl	Cu(IO ₃) ₂	Glycine	Cu(IO ₃) ₂		Alanine	Cu(IO ₃) ₂	
0.0	0.003245	0.01253	0.004096	3.32	0.01252	0.00398	3.40
.00501	.003398	.02509	.004805	3.31	.02508	.00460	3.37
.01002	.003517	.05023	.00617	3.35	.05019	.00584	3.40
.02005	.003730	.07542	.00746	3.37	.07541	.00698	3.43
.03511	.003975	.1008	.00872	3.38	.1008	.00806	3.44
.05017	.004166	.1515	.01116	3.39	.1516	.01022	3.47
.07529	.004453	.2025	.01352	3.41	.2027	.01230	3.49
.1005	.004694						

(Results of Evans and Monk, 1954)

In Sodium Glycollate Solutions		In Sodium Lactate Solutions	
Moles per liter sat. sol.		Moles per liter sat. sol.	
NaG ₁	$\text{Cu}(\text{IO}_3)_2$	NaL	$\text{Cu}(\text{IO}_3)_2$
0.01512	0.00645	0.01269	0.00634
.02016	.00736	.01904	.00770
.03017	.00899	.02538	.00883

Other Results:

Peterson and Meyers, 1930 determined the solubility of $\text{Cu}(\text{IO}_3)_2$ in aq. solutions of KCl , K_2SO_4 , MgCl_2 and MgSO_4 but their tables do not show the concentrations of salts employed — only the resulting calculated activity coefficients, (25°).

(Cont.)

Monk, 1951 gives data on the solubility of $\text{Cu}(\text{IO}_3)_2$ in solutions containing alanine + HCl, alanine + NaOH, glycyl glycine + HCl and glycyl glycine + NaOH at 25°.

Lloyd, Wycherley and Monk, 1951 report the solubility of $\text{Cu}(\text{IO}_3)_2$ in mixtures of 17 carboxylic acids + their sodium salts at 25°.

COPPER PERIOATES

10

(Data of Nasanen, 1954)

Compound	Solubility Product
Cu_2HIO_6	$[\text{Cu}][\text{OH}]^{1.5}[\text{H}_4\text{IO}_6]^{0.5} = 10^{-21.02}$
$\text{Cu}_3(\text{IO}_6)_2$	$[\text{Cu}][\text{OH}]^{1.6}[\text{H}_4\text{IO}_6]^{0.4} = 10^{-21.71}$
Cu_2NaIO_6	$[\text{Cu}][\text{Na}]^{0.5}[\text{OH}]^2[\text{H}_4\text{IO}_6]^{0.5} = 10^{-26.26}$

COPPER NITRATE $\text{Cu}(\text{NO}_3)_2$

NO

SOLUBILITY OF COPPER NITRATE IN WATER

The results of Funk, 1900; Kazantzev, 1923, 1925; Massink, 1918; Fedotieff, 1911-12; Wilcox and Bailey, 1927; and Bruvlants and Mund, 1919, for the Eutectic, were plotted on cross section paper and the following average results read from the curve. The original data are found in the tables which follow. Wilcox and Bailey, 1927 and Schreinemakers, Berkhoff and Posthumus, 1924 found that the supposed trihydrate is really $\text{Cu}(\text{NO}_3)_2 \cdot 2\frac{1}{2} \text{H}_2\text{O}$.

t°	Gms. $\text{Cu}(\text{NO}_3)_2$ per 100 gms. sat. solution	Solid Phase
-10	29.0	Ice
-20	34.0	"
-26.37 (Eutec.)	39.0	" + $\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-20	40.0	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-10	42.5	"
0	45.5	"
+10	50.0	"
20	55.5*	"
25	60.1	"
25.4 (tr. pt.)	60.8	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ + $\text{Cu}(\text{NO}_3)_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$
30	61.0	$\text{Cu}(\text{NO}_3)_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$
40	62.0	"
50	63.2	"
60	64.5	"
70	66.0	"
80	67.5	"
90	69.0	"
100	71.2	"

* d_{20} sat. sol. = 1.688. (Fedotieff, 1911-12)

Cu CUPRUM

SOLUBILITY OF COPPER NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID (Kazantzev, 1923, 1925)

The figures in the second column show the temperatures below which, in each case, the solid phase is $\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and above which, it is $\text{Cu}(\text{NO}_3)_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$.

	Gms. HNO_3 per 100 gms. sat. sol.	Tr. t° of $.6\text{H}_2\text{O} \rightarrow (.2\frac{1}{2}\text{H}_2\text{O})$	Gms. $\text{Cu}(\text{NO}_3)_2$ per 100 gms. sat. sol. at					
			0°	10°	15°	25°	50°	75°
NO	0	25.4	46.3	50.3	52.4	60.3	63.5	67.3
	5	23.2	41.3	45.4	48.2	55.3	59.0	63.0
	10	21.0	36.5	40.7	44.3	50.5	54.6	58.9
	15	18.8	31.9	36.6	40.8	45.7	50.1	54.7
	20	16.6	27.6	32.6	37.7	41.0	45.7	50.4
	30	12.2	19.7	26.5	30.5	31.9	36.9	41.8
	40	7.8	14.3	21.0	21.5	23.0	28.2	33.6
	50	-	11.4	12.2	13.6	15.0	19.8	25.3
	60	-	-	-	7.2	8.5	12.0	17.5
	70	-	-	-	2.6	3.6	5.9	11.2
	80	-	0.3	-	1.2	1.3	3.2	11.7
	95	-	0.9	-	1.3	1.7	-	-

Data for the solubility of copper nitrate in aq. ammonia solutions are given by Stasevich, 1913.

THE SYSTEM COPPER NITRATE - COPPER SULFATE - WATER (Massink, 1918)

Data for the solubility of copper nitrate in aq. solutions of copper sulfate and of sodium nitrate at 20° are also given by Massink, 1916 and 1917.

Results At 20°

Gms. per 100 gms. sat. sol.		Solid Phase
CuSO_4	$\text{Cu}(\text{NO}_3)_2$	
0.0	54.94	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
1.2	55.28	"
1.08	55.08	" + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
1.69	40.24	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
2.42	34.24	"
7.77	11.51	"
17.52	0.0	"

Results at 35°

Gms. per 100 gms. sat. sol.		Solid Phase
CuSO_4	$\text{Cu}(\text{NO}_3)_2$	
0.0	60.92	$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} (2\frac{1}{2}\text{H}_2\text{O})$
1.27	60.53	" + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
1.02	59.11	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
0.70	54.67	"
0.86	51.90	"
1.62	43.10	"
11.04	11.37	"
21.00	0.0	"

THE SYSTEM COPPER NITRATE - SODIUM NITRATE - WATER AT 20°
(Massink, 1918)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
NaNO ₃	Cu(NO ₃) ₂		NaNO ₃	Cu(NO ₃) ₂	
0.0	55.95	Cu(NO ₃) ₂ ·6H ₂ O	43.50	3.38	NaNO ₃
2.07	55.76	"	46.80	0.0	"
4.29	54.34	"	1.98	57.0	Cu(NO ₃) ₂ ·3H ₂ O* (2½H ₂ O)
5.27	53.30	" + NaNO ₃	3.59	57.0	"
8.19	46.32	NaNO ₃	5.66	56.57	" + NaNO ₃ *
19.89	29.25	"	*Unstable		

NO

THE SYSTEM COPPER NITRATE - AMMONIUM NITRATE - WATER
(Schreinemakers, Berkhoff and Posthumus, 1924)

Results at 30°

Results at 40°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Cu(NO ₃) ₂	NH ₄ NO ₃		Cu(NO ₃) ₂	NH ₄ NO ₃	
0.0	71.18	NH ₄ NO ₃	0.0	74.0	NH ₄ NO ₃
9.80	59.95	"	8.2	65.2	"
26.37	44.82	"	14.17	58.4	"
33.96	39.95	"	36.8	43.6	"
38.07	38.35	"	42.0	43.9	" + D
43.01	38.24	"	43.9	41.7	D
43.90	40.60	" + D	48.0	36.7	"
45.04	39.21	D	47.9	36.7	" + Cu(NO ₃) ₂ ·2½H ₂ O
45.30	38.8	" + Cu(NO ₃) ₂ ·2½H ₂ O	48.1	36.4	Cu(NO ₃) ₂ ·2½H ₂ O
50.00	27.41	Cu(NO ₃) ₂ ·2½H ₂ O	50.7	24.1	"
55.80	12.75	"	56.9	11.9	"
61.00	0.0	"	62.6	0.0	"

D = Cu(NO₃)₂·[NH₄NO₃]₃.

Meyer, 1924 failed to find the double salt.

DISTRIBUTION OF COPPER NITRATE BETWEEN WATER AND ORGANIC SOLVENTS AT 20°
(Warner, 1953)

Solvent	Gms. Cu(NO ₃) ₂ per 100 gms. solution		Solvent	Gms. Cu(NO ₃) ₂ per 100 gms. solution		
	Aqueous Phase	Organic Phase		Aqueous Phase	Organic Phase	
n-Butanol	54.1	32.8*	Dibutyl carbitol	55.6	3.32	
	45.5	21.7		53.7	2.01	
	40.9	16.6		52.5	1.29	
	34.4	11.0		52.2	1.49	
	21.9	3.9		51.4	1.00	
diethyl ether	13.0	1.4	Methyl isobutyl ketone	49.3	0.63	
	55.7	0.49*		47.0	0.34	
	50.1	0.13		45.0	0.22	
	46.8	0.06		41.0	0.09	
	40.1	0.01		55.9	1.92	
*System saturated with Cu(NO ₃) ₂ ·3H ₂ O (2½ H ₂ O?).				52.1	0.80	
				50.3	0.49	
				39.6	0.05	

Cu CUPRUM

SOLUBILITY OF $\text{Cu}(\text{NO}_3)_2$ IN OTHER SOLVENTS

Solvent	t°	Solubility
Ethyl Ether	19	A solution saturated with $\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ contains 5.62 gms. $\text{Cu}(\text{NO}_3)_2$ per liter of ether. (Bachelet, Cheylan and Le Bris, 1950)
Furfural	25	100 gms. sat'd. solution in furfural contain 0.03 gms. $\text{Cu}(\text{NO}_3)_2$. (Trimble, 1941)
Hydrazine	Room	100 cc anhydrous hydrazine dissolve 1 gm. copper nitrate, with decomposition. (Welsh and Broderson, 1915)

NO COPPER (ic) Trihydroxy NITRATE

The solubility product at 25° in Potassium nitrate solutions was determined by Nasanen and Tamminen, 1949.

O CUPROUS OXIDE Cu_2O SOLUBILITY IN AQUEOUS AMMONIA SOLUTIONS AT 25°
(Donnan and Thomas, 1911)

The cuprous oxide was prepared by adding KOH solution to a mixture of equal weights of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and sucrose dissolved in water, until nearly all the precipitate had redissolved. The solution was kept at 70° until the cuprous oxide had separated. Two batches were prepared. The first, No. I, obtained from the more dilute solution, was bulky and dark red in color, Cu = 88.62%. The second, No. II, was bright red, Cu = 88.59%. The solubility determinations were made with extreme care. A special apparatus was used. By means of this, the constituents of the mixtures were introduced into the bottles in an atmosphere of hydrogen and every precaution taken to prevent oxidation. The bottles were sealed and rotated for 2-4 weeks at constant temperature. In case the slightest tinge of blue developed in a bottle (indicating oxidation), it was rejected.

Results for Preparation No. I				Results for Preparation No. II			
Gms. per 1000 Gms. Sol.		Gms. per 1000 Gms. Sol.		Gms. per 1000 Gms. Sol.		Gms. per 1000 Gms. Sol.	
Cu	NH_3	Cu	NH_3	Cu	NH_3	Cu	NH_3
0.3593	3.91	0.00566	0.23	0.4229	7.82	0.00665	0.46
0.6869	13.77	0.01080	0.81	0.6678	8.16	0.01050	0.48
1.0144	27.03	0.01597	1.59	0.9890	22.61	0.01555	1.33
1.0462	32.64	0.01645	1.92	1.0494	28.39	0.01650	1.67
1.3229	68.68	0.02081	4.04	1.3528	54.15	0.02127	3.19
1.4882	74.12	0.02340	4.36	1.5048	72.08	0.02366	4.24
1.6313	98.52	0.02565	5.56	1.5963	78.20	0.02510	4.60
1.6981	122.40	0.02670	7.20	1.6555	102.05	0.02603	6.00

SOLUBILITY IN WATER CONTAINING CARBON DIOXIDE AT 20°
(Tronstad and Veimo, 1940)

Gms. CO ₂ per liter	Mg. Cu ₂ O per liter
0.0	0.1
.31	5.4
.60	6.4

0.0000054 gms. of Cu₂O dissolve in one cc of oxygen free sea water at pH = 8.1 at 25°. (Ferry and Riley, 1946). 0.6 mg. Cu₂O dissolve in a liter of Baltic sea water at 18°. (Ragg, 1950).

Data for the system Cu₂O - PbO are given by Gebhardt and Obrowski, 1954.

The reactions occurring at 700° between Cu₂O + MnS and Cu₂O + Cu₂S were studied by Schenck and Keuth, 1940.

CUPRIC OXIDE CuO

CUPRIC HYDROXIDE Cu(OH)₂

O
OH

SOLUBILITY IN WATER

t°	Ksp[(Cu ⁺⁺)(OH ⁻) ₂]	Solubility moles per liter	Author
Room	1 x 10 ⁻¹⁹	-	(Allmand, 1909)
Room	1 x 10 ⁻²⁰	-	(Britton, 1925)
Room	-	6.1 x 10 ⁻⁵	(Jellinek and Gordon, 1924)
18°	-	6.9 x 10 ⁻⁵	(Remy, 1925; Remy and Kuhlman, 1924)
25	-	3.0 x 10 ⁻⁵	(McDowell and Johnston, 1936)
Room	1.6 x 10 ⁻¹⁹	-	(Oka, 1940)
Room	3.9 x 10 ⁻¹⁹	-	(Nasanen, 1942a)
20-30°	5 x 10 ⁻¹⁹	-	(Geloso and Deschamps, 1947)
Room	2.2 x 10 ⁻²⁰ (thermodynamic)	-	(Nasanen and Tamminen, 1949)
25-28°	1.5 x 10 ⁻²⁰	-	(Sircar and Prasad, 1956)
18°	1.31 x 10 ⁻²⁰ (thermodynamic)	-	(Aksel'rud and Fialkov, 1950)

SOLUBILITY OF CUPRIC OXIDE IN WATER CONTAINING CARBON DIOXIDE AT 20°
(Tronstad and Veimo, 1940)

Gms. CO ₂ per liter	Mg. CuO per liter
0.0	0.15
.07	8.5
.20	22.7
.32	44.2

0.08 mg. CuO dissolve a liter of Baltic sea water at 18°. (Ragg, 1950). One cc of sea water will dissolve 1 x 10⁻⁹ gms. CuO or 1.3 x 10⁻⁸ gms. Cu(OH)₂ at pH 8.1 at 25°. (Ferry and Riley, 1946).

Cu CUPRUM

SOLUBILITY OF CUPRIC OXIDE IN AQUEOUS SOLUTIONS OF POTASSIUM HYDROXIDE AT 25° (McDowell and Johnston, 1936)

OH The present results at the lower concentrations of alkali supplement those of Muller, 1923 (below). The cupric oxide was prepared by dropping 0.06 N solutions of CuSO_4 and KOH simultaneously into boiling conductivity water. The precipitation and subsequent washing was performed in an atmosphere of nitrogen. Equilibrium was approached from below and from above. The solutions were agitated at least 14 days and 7 days allowed for sedimentation. The clear supernatant solutions were filtered through a No. 1 sintered jena glass filter, discarding the first portions. The copper was determined by electrometric titration with potassium ferrocyanide as precipitant.

Molality of KOH	Gm. Mols. $\text{Cu} \times 10^{-5}$ per 1000 gms. H_2O		Molality of KOH	Gm. Mols. $\text{Cu} \times 10^{-5}$ per 1000 gms. H_2O		Molality of KOH	Gm. Mols. $\text{Cu} \times 10^{-5}$ per 1000 gms. H_2O	
	$\text{Cu} \times 10^{-5}$	per 1000 gms. H_2O		$\text{Cu} \times 10^{-5}$	per 1000 gms. H_2O		$\text{Cu} \times 10^{-5}$	per 1000 gms. H_2O
0.0417	0.070		0.2637	1.30		2.848	92.9	
0.0586	0.154		0.3163	3.88		3.18	119.3	
0.0741	0.192		0.544	5.13		4.151	147.0	
0.0932	0.412		0.753	11.35		4.227	160.0	
0.1150	0.316		1.000*	16.1		5.065	175.0	
0.1385	0.385		1.633	33.3		5.253	192.0	
0.1772	0.526		1.963	68.3		6.05	297.0	
0.2165	0.85		2.333	81.2		8.38	435.0	

Three determinations in aqueous sodium hydroxide gave the following results:

Molality of NaOH	2.212	3.247	4.227
Gm. Mols. $\text{Cu} \times 10^{-5}$ per 1000 gms. H_2O	70.7	92.5	180.0

*Meites (1949) reports 2.18×10^{-3} moles Cu^{+2} dissolved in 1M KOH solution in equilibrium with a dark brown solid (CuO?).

A series of determinations by Melbye, 1922, made by the very gentle addition of a solution of copper sulfate to sodium hydroxide solutions until turbidity appeared, gave results which showed that between 2.65 and 6.6 normal NaOH, the solubility of copper hydroxide increases at a linear rate (from 0.028 to 0.195 normal) with the concentration of the NaOH. [Both these and Meite's data (above) are in the presence of carbon dioxide.]

EQUILIBRIUM IN THE SYSTEM COPPER OXIDE, COPPER HYDROXIDE, CUPRIT AND CAUSTIC SODA (E. Muller, 1920 and 1923)

The author gives numerical data for the solubility of CuO and of $\text{Cu}(\text{OH})_2$ in caustic soda solutions of concentrations varying from 0 to 20 normal, at various temperatures and lengths of time of shaking. The rapidity with which equilibrium was reached varied with the concentration of the sodium hydroxide. A selection of the results representing final equilibrium is difficult and their value for practical purposes is

uncertain. For this reason a choice of the author's determinations was not made for the present compilation. Among the conclusions drawn from the work, may be mentioned the following:

(1) Blue copper hydroxide dissolves in considerable amount in strong caustic soda solutions of less than 17 normal, and from such solutions a brownish black precipitate gradually separates. The undissolved material also gradually becomes brown. These dark colored compounds are probably solid solutions of CuO and $\text{Cu}(\text{OH})_2$ in which the relation of $\text{Cu}(\text{OH})_2$ to water content has a general connection with the copper concentration of the supernatant solution. The dehydration of $\text{Cu}(\text{OH})_2$ takes place gradually over a considerable series of these solid solutions but does not go to anhydrous CuO .

OH

(2) The solubility of CuO and of $\text{Cu}(\text{OH})_2$ increases at first with the strength of the caustic, but beyond a certain concentration it diminishes. The solubility of $\text{Cu}(\text{OH})_2$ is considerably greater than that of CuO , especially in dilute solutions. Both CuO and $\text{Cu}(\text{OH})_2$ are converted to cuprit, by treatment with strong caustic solutions.

(3) A copper (II) acid sodium can be crystallized from aqueous alkali solutions and it possesses a cobalt color and probably has the composition Na_2CuO_2 .

(4) The opinion that copper hydroxide dissolves as a colloid is no longer justified.

For further data see Justin-Mueller, 1918.

THE SOLUBILITY OF $\text{Cu}(\text{OH})_2$ IN SODIUM HYDROXIDE SOLUTIONS (Arkhipov, Flakshver and Podbornova, 1950)

At 15°

At 20°

Grams per liter sat. sol.

Grams per liter sat. sol.

At 15°		At 20°	
NaOH	Cu	NaOH	Cu
56.4	0.10	68.4	0.25
120.8	0.31	132.0	0.82
172.8	0.89	202.0	2.87
209.6	1.19	360.0	10.4
240.0	2.61		

SOLUBILITY OF $\text{Cu}(\text{OH})_2$ IN AQUEOUS AMMONIA SOLUTIONS Results of Dawson, 1909 at 18°

Moles per liter		Moles per liter		Moles per Liter	
NH_3	Cu	NH_3	Cu	NH_3	Cu
0.2	0.00054	2.5	0.0442	5.8	0.1238*
0.5	0.0033	2.95	0.0590*	6.0	0.1254
1.0	0.0109	3.0	0.0548	8.0	0.1599
1.5	0.0204	4.0	0.0784	9.96	0.1787
2.0	0.0314	5.0	0.1041	11.78	0.1531*

*Arkhipov. 1942 at 18-20°.

(Cont.)

Cu CUPRUM

Results of
Archipov and Paksver, 1939
at 20°

% NH ₃	Gms. Cu per liter
13.15	8.40
21.75	13.75
26.3	18.92

Results of
Arkhipov and Plakshver
and Podbornova, 1950 at 20°

Gms. per liter sat. sol.	
NH ₃	Cu
43.9	3.75
78.2	8.2
123.7	11.9
204.0	15.5

OH *A solution of CuO in 21.75% aqueous NH₃ at 20° contains 2.46 gms. Cu per liter. Archipov and Paksver, 1939.

SOLUBILITY OF COPPER HYDROXIDE IN AMMONIA SOLUTIONS CONTAINING OTHER SUBSTANCES AT 18-20° (Arkulov, 1948)

30 gms. Cu(OH)₂ were taken for each determination; stirred 18 hours.

Added:	Gms. added per liter	Gms. Cu dissolved per liter		
		50 gms. NH ₃ per liter	100 gms. NH ₃ per liter	200 gms. NH ₃ per liter
Pyridine	0.0	3.75	7.87	
	10.0	3.62	7.38	
	25.0	3.37	7.12	
	50.0	2.95	6.50	
Urea	3.0	3.75	7.90	
Aniline	0.0			9.73
	5.1			9.65
	16.2			9.65
	20.4			9.12

The author also gives data for the variation in the solubility of Copper Hydroxide in ammonia alone, with time of stirring, amount of sample taken, and amount of ammonia added. Other data are given for the addition of NH₄CNS, (NH₄)₂CO₃, (NH₄)₂SO₄ and NaOH.

Data showing the effect of increasing amounts of (NH₄)₂SO₄, Ba(OH)₂, NaOH and of Na₂SO₄ upon the solubility of cupric hydroxide in aqueous ammonia solution at 18°, are given by Dawson, 1909a.

SOLUBILITY OF CUPRIC HYDROXIDE IN AMMONIA SOLUTIONS CONTAINING VARIOUS "POLY-OXY" COMPOUNDS AT 20° (Archipov and Bykov, 1951)

Data in moles Cu⁺⁺ per liter; read from the authors' graph.

Added "poly-oxy" compound and concentration	Grams NH ₃ per liter				
	25	50	100	150	200
NONE	0.02	0.05	0.11	0.145	0.15
Rochelle salt (0.125 M)	.145	.19	.27	.33	-
" " (0.10 M)	.12	.16	.24	.28	.30
Hydroxycellulose (0.10 M)	.03	.09	.17	.22	.23
Sucrose (0.05 M)	.06	.09	.17	.20	.21
Cellulose (0.091 M)	-	.05	.16	.19	.21
Oxycellulose (0.095 M)	-	.08	.17	.20	.23

SOLUBILITY OF CuO IN SOLUTIONS OF ACIDS

OH

In aq. HNO_3 at 25-28°

In aq. HF at 25°

(Sircar and Prasad, 1956)

(Jaeger, 1901)

Initial Molarity HNO_3	Total Cu Molarity	pH
0.0201	0.0100	5.28
.0402	.0200	5.20
.0604	.0301	5.11
.0805	.0384	5.02
.1006	.0482	4.95
.1207	.0580	4.84
.1408	.0676	4.74
1.0	.4802*	-

Normality of HF	Gm. Atoms Cu per Liter
0.12	0.0307
0.28	0.1164
0.57	0.2494
1.08	0.388
2.28	0.463

Data are also given for
HF + KF solutions.In aq. CH_3COOH at 25°
(Jaeger, 1901)

Normality of Acid	Gm. atoms Cu per Liter
1.0	0.1677

*Jaeger, 1901.

Data for the system $\text{Cu}(\text{OH})_2 + \text{AgNO}_3 + \text{H}_2\text{O}$ at 20° are given by Malquori, 1925. The results show the range of AgNO_3 concentration over which basic $\text{Cu}(\text{OH})_2\text{--AgNO}_3$ salts exist.

Data for the system $\text{Cu}(\text{OH})_2 - \text{HgCl}_2 - \text{H}_2\text{O}$ between 17 and 100°, showing the presence of 3:2 and 3:1 double salts is given by Lamure, 1949.

The solubility of CuO in molten CuCl , KCl and CuCl_2 is given by Fontana, Gorin, Kidder and Kinney, 1952.

COPPER PHOSPHATES

PO

THE SYSTEM $\text{CuO} - \text{P}_2\text{O}_5 - \text{H}_2\text{O}$ AT 60°
(Guerin and Kozicki, 1952)Gms. per 100
gms. sat. sol.

CuO	P_2O_5	Solid Phase
> (3.6	59.2)	$\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot 2\text{H}_2\text{O}$
3.6	59.2	$\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot 2\text{H}_2\text{O} + 2\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$
0.56	2.15	$2\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot 3\text{H}_2\text{O} + 4\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot \text{H}_2\text{O}$
< (0.56	2.15)	$4\text{CuO} \cdot \text{P}_2\text{O}_5 \cdot \text{H}_2\text{O}$

COPPER Tetrapyrroline PERRHENATE $[\text{Cu}(\text{C}_5\text{H}_5\text{N})_4](\text{ReO}_4)_2$

ReO

At 20°, the solubility is 5.555 gms. per liter. Druce, 1948.

Cu CUPRUM

S CUPROUS SULFIDE Cu_2S

SOLUBILITY OF CUPROUS SULFIDE IN WATER

Calculating from the results of Jellinek and Czerwinski, 1922, Ravitz, 1936, found the Solubility of Cuprous Sulfide, Cu_2S , in Water to be 4.24×10^{-15} gm. mols. per liter at 10° and 1.19×10^{-14} gm. mols. per liter at 25° . The solubility product is 1.0×10^{-31} at 10° and 3.6×10^{-30} at 25° . Ruff, 1929 gives 8.5×10^{-45} for the mineral Covellite. More recent estimates are 2.6×10^{-49} (Kapustinsky, 1940) and 1×10^{-48} (Goates, Gordon and Faux, 1952) (Both from thermochemical data).

Fusion-point data are given for mixtures of:

$\text{Cu}_2\text{S} + \text{Ag}_2\text{S}$	(Friederich, 1907-08)
" + FeS	(Shad and Bornemann, 1916; Carpenter and Haywood, 1923; Kushima and Asano, 1953)
" + PbS	(Friederich, 1907-08; Schwarz and Romero, 1927)
" + Sb_2S_3	(Chikashige and Hamachi, 1916)
" + ZnS	(Friederich, 1907-08)
" + Ni_2S_3	(Kushima and Asano, 1953)
" + $\text{FeS} + \text{Ni}_2\text{S}_3$	(" " " ")
" + CuS	(Buerger, 1939, 1941; Ramdohr, 1943)

S CUPRIC SULFIDE CuS

SOLUBILITY OF CUPRIC SULFIDE IN WATER

Critical reviews of the published determinations of the solubilities of the metal sulfides in water are given by Kolthoff, 1931, and Ravitz, 1936. Kolthoff calls attention to the incorrectness of Weigel's, 1906, figures. The preferred value for cupric sulfide, calculated by Ravitz with the aid of recent activity data, is 2.55×10^{-15} gm. mols. per liter at 25° . The Solubility Product is 3.48×10^{-38} at 25° . More recent estimates, calculated from thermochemical data are 3.2×10^{-38} (Kapustinsky, 1940) and 8×10^{-36} (Goates, Gordon and Faux, 1952).

100 cc sat. aq. sodium sulfide solution (of d. = 1.225) dissolve 0.0032 gm. CuS . (Holland, 1897)

SOLUBILITY OF COPPER SULFIDE IN AQUEOUS SUGAR SOLUTIONS (Stolle, 1900)

% Sugar in Solvent	Gms. CuS per Liter of Aq. Sugar Solution at:		
	17.5°	45°	75°
10	0.5672	0.3659	1.1345
30	0.8632	0.7220	1.2033
50	0.9076	1.0589	1.2809

COPPER SULFITE $\text{CuSO}_3 \cdot 2\text{H}_2\text{O}$

30

The equilibrium diagram for the system $\text{CuO} + \text{SO}_2 + \text{H}_2\text{O}$ at 15 and at 25°, determined by the synthetic method, is given by Terrea and Ruhl, 1934, but the numerical results are communicated only in the detailed report published as Beihefte zu den Zeitschriften des Vereins deutscher Chemiker No. 8 1934, Verlag Chemie, Berlin W. 35 Cornelius str, 3.

COPPER FLUO SULFATES

SOLUBILITY OF EACH IN WATER
(Lange, 1927)

Compound	Formula	Gme. Compound per t° 100 cc sat. sol.
Copper Tetra Ammine Fluoro Sulfonate	$\text{Cu}(\text{SO}_3\text{F})_2 \cdot 4\text{NH}_3$	12 52.9
" " Pyridine "	$\text{Cu}(\text{SO}_3\text{F})_2 \cdot 4\text{Py}$	12.5 2.747

COPPER SULFATE CuSO_4

30

SOLUBILITY IN WATER

(Etard, 1894; Agde and Barkholt, 1926; Miles and Menzies, 1937)
also: (1) Crockford and Brawley, 1932, (2) Caven and Johnston, 1927,
(3) Foote, 1919, (4) Flottmann, 1928, (5) Massink, 1917-18,
(6) Crockford and Webster, 1930 (7) Cohen, 1903.

The freezing-point of a 0.1 normal aqueous CuSO_4 solution is - 0.209°; that of a 0.25 normal solution is - 0°.469 and a 0.5 normal solution it is - 0°.859. (Klein and Svanberg, 1920-1921)

Gms. CuSO_4 per 100 gms. sat. sol.

t°	Etard 1894	Agde & Barkholt 1926	Miles & Menzies 1937	Others	Density (A. & B.)	Solid Phase
- 1.5	-	12.70	11.9	-	1.146	Ice + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
0	12.5	12.9	12.3	12.87 (1), 12.93 (2)	1.149	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
+ 10	14.8	14.96	14.5	16.19 [12] (3)	1.176	"
15	-	-	15.7	16.12 (4)	1.1839 (4)*	"
20	17.2	17.00	16.8	17.30 (4), 17.52 (5)	1.198 1.1965, (4)	"
25	-	-	18.2	18.49 av. (2)(3)(4)(7)	1.2111 (4)	"
30	20.0	19.52	19.4	-	1.232	"
40	22.5	22.23	22.3	21.88 37.5° (2)	1.262	"
50	25.0	25.17	25.3	26.90 55° (6)	1.299	"
60	28.5	28.3	28.5	-	1.343	"
70	-	32.1	32.0	-	1.398	"
80	35.5	34.9	35.9	-	1.433	"
90	-	39.2 (93°)	40.3	-	1.504 (93°)	"
95.9	-	40.4	43.4	-	1.521	" + $\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$
100	43.0	42.2	43.5	-	1.550	$\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$
110	-	-	43.8	-	-	"
120	44.0	-	-	-	-	"
140	44.5	-	-	-	-	"
160	44.0	-	-	-	-	"
180	43.0	-	-	-	-	"

*d₁₄° = 1.193 (Greenish, 1902)

Cu CUPRUM

SOLUBILITY OF CUPRIC SULFATE IN ORDINARY WATER AND IN
DEUTERIUM (98.1% D₂O) WATER
(Miles and Menzies, 1937)

t°	Gm. Mols. CuSO ₄ (159.61) per 1000 gms. (55.51 mols.) water		Solid Phase
	In H ₂ O	In D ₂ O	
- 1.5 (Eu.)	0.85	-	Ice + CuSO ₄ ·5 aq.
0	0.88	-	CuSO ₄ ·5 aq.
- 2.7 (Eu.)	-	0.79	Ice + CuSO ₄ ·5 aq.
5	0.96	0.83	CuSO ₄ ·5 aq.
10	1.06	0.93	"
15	1.17	1.05	"
20	1.27	1.16	"
25	1.39	1.29	"
30	1.51	1.42	"
35	1.65	1.56	"
40	1.80	1.71	"
45	1.95	1.86	"
50	2.12	2.04	"
55	2.30	2.22	"
60	2.49	2.42	"
65	2.71	2.64	"
70	2.95	2.88	"
75	3.21	3.14	"
80	3.51	3.44	"
85	3.84	3.77	"
90	4.23	4.16	"
95	4.70	4.62	"
95.9 (tr. pt.)	4.80	-	" + CuSO ₄ ·3 aq.
96.2 (tr. pt.)	-	4.75	" + "
100	4.82	4.77	CuSO ₄ ·3 aq.
105	4.85	4.80	"
110	4.88	4.83	"

SOLUBILITY OF COPPER SULFATE IN SULFURIC ACID SOLUTIONS

Agde and Barkholt (1927) made an extensive investigation (0-80°) by determining cooling curves. The accuracy of the method was questioned by Crockford and Warrick (1930). Tunell and Posnjak (1931) believe that some of the triple point data of Crockford and Warrick also do not represent equilibrium. Binder's data (1936) at 100° agree with those of Posnjak and Tunell (1929).

Because of the variety of units involved, the data of each author have been kept intact. To compare results at a particular temperature, check each table listed below:

t°	Authors - (page numbers given in parentheses)
0	Agde and Barkholt, 1927 (967); Crockford and Warrick, 1930 (969); Engel, 1887 (969)
10	Agde and Barkholt, 1927 (967)
12	Foote, 1919 (969)
20	Agde and Barkholt, 1927 (967); Crockford and Warrick, 1930 (969)

(Cont.)

t* Authors - (page numbers given in parentheses)

22	Binder, 1936 (970)	
25	Goodwin and Horsch, 1919 (970); Foote, 1919 (970); Foote, 1915 (970); Bell and Tabor, 1908 (970); Britton 1925 (971)	
30	Agde and Barkholt, 1927 (968); Cameron and Crockford, 1929 (971)	
40	" " " " (968); Crockford and Warrick, 1930 (969)	
50	" " " " (968); Posnjak and Tunell, 1929 (972)	
55	Crockford and Warrick, 1930 (969)	
60	Agde and Barkholt, 1927 (968)	
70	" " " " (968)	
80	" " " " (968)	
100	Posnjak and Tunell, 1929 (972); Binder, 1936 (970)	30
200	Tunell and Posnjak, 1930 (972)	

EQUILIBRIUM IN THE SYSTEM COPPER SULFATE, SULFURIC ACID AND WATER
AT VARIOUS TEMPERATURES
(Agde and Barkholt, 1927)

Results at 0.5°

d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	H ₂ SO ₄	CuSO ₄ ·5H ₂ O	
1.161	8.58	14.91	CuSO ₄ ·5H ₂ O
1.184	13.98	11.92	"
1.228	24.70	6.25	"
1.245	28.80	4.42	"
1.360	44.90	0.76	"
1.379	47.00	1.17	"
1.405	49.74	0.82	"
1.441	52.76	0.80	CuSO ₄ ·3H ₂ O

Results at 10°

1.184	8.40	16.95	CuSO ₄ ·5H ₂ O
1.195	13.50	14.00	"
1.204	15.23	12.75	"
1.220	21.00	9.00	"
1.256	28.30	5.77	"
1.273	32.04	4.10	"
1.365	44.60	1.73	"
1.381	46.50	1.53	"
1.409	49.47	1.45	"
1.442	52.48	1.35	CuSO ₄ ·3H ₂ O

Results at 20°

1.210	12.56	17.30	CuSO ₄ ·5H ₂ O
1.244	29.92	10.54	"
1.254	27.44	7.10	"
1.274	31.40	5.52	"
1.366	43.90	3.05	"
1.384	46.00	3.00	"
1.409	48.62	2.73	"
1.442	51.64	2.76	CuSO ₄ ·3H ₂ O

(Cont.)

Cu CUPRUM

**EQUILIBRIUM IN THE SYSTEM COPPER SULFATE, SULFURIC ACID AND WATER
AT VARIOUS TEMPERATURES--Contd.**

d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	
	H_2SO_4	$CuSO_4 \cdot 5H_2O$		
Results at 40°				
30	1.252	7.40	28.00	$CuSO_4 \cdot 5H_2O$
	1.261	11.03	25.25	"
	1.261	13.25	23.40	"
	1.276	23.16	15.75	"
	1.283	24.92	15.32	"
	-	29.14	12.42	"
	1.368	41.00	8.30	"
	1.388	42.80	8.56	"
	1.390	43.22	8.63	"
	1.445	49.24	7.84	$CuSO_4 \cdot 3H_2O$
Results at 60°				
	1.318	6.25	38.76	$CuSO_4 \cdot 5H_2O$
	1.333	9.80	35.75	"
	1.327	11.50	33.48	"
	1.341	19.55	27.76	"
	1.342(?)	21.46	26.52	"
	1.365	25.02	24.63	"
	1.398	35.05	18.40	"
	1.417	38.90	16.53	" + $CuSO_4 \cdot 3H_2O$
	1.418	39.20	16.60	$CuSO_4 \cdot 5H_2O$
Results at 80°				
	1.414	4.40	50.15	$CuSO_4 \cdot 5H_2O$
	1.417	7.80	47.55	"
	1.408	9.15	45.80	"
	1.413	15.14	40.80	"
	1.414	18.00	38.00	"
	1.450	31.15	28.30	$CuSO_4 \cdot 3H_2O$
	1.455	35.25	25.35	"
	1.463	36.10	24.80	"

Similar results are also given for 30°, 50° and 70°.

(Cont.)

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT
VARIOUS TEMPERATURES
(Crockford and Warrick, 1930)

Results at 0°			Results at 20°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuO	SO ₃		CuO	SO ₃	
7.34	7.40	CuSO ₄ ·5H ₂ O	8.43	8.89	CuSO ₄ ·5H ₂ O
3.14	14.55	"	7.06	12.24	"
1.50	21.23	"	4.51	18.49	"
1.18	23.52	"	3.97	21.03	"
0.15	34.60	"	1.68	29.32	"
0.30	41.07	"	1.25	35.84	"
0.59	43.39	" + CuSO ₄ ·3H ₂ O	1.04	43.11	" + CuSO ₄ ·3H ₂ O
0.47	47.44	CuSO ₄ ·3H ₂ O	0.23	45.32	CuSO ₄ ·3H ₂ O
0.09	48.54	CuSO ₄ ·H ₂ O	0.71	48.44	" + CuSO ₄ ·H ₂ O
0.05	65.52	"	0.18	53.42	CuSO ₄ ·H ₂ O
0.09	71.93	"	0.05	60.17	"
0.02	73.58	" + CuSO ₄	0.09	72.19	" + CuSO ₄

30

Results at 40°			Results at 55°		
Density	Gms. per 100 Grams H ₂ O	Solid Phase	Density	Gms. per 100 Grams H ₂ O	Solid Phase
	H ₂ SO ₄			H ₂ SO ₄	
10.21	10.34	CuSO ₄ ·5H ₂ O	13.16	13.41	CuSO ₄ ·5H ₂ O
8.63	13.37	"	9.88	17.82	"
6.91	17.09	"	6.07	24.45	"
4.03	26.05	"	5.75	29.82	"
2.75	31.95	"	5.05	34.42	" + CuSO ₄ ·3H ₂ O
2.19	38.78	CuSO ₄ ·3H ₂ O	3.45	40.62	CuSO ₄ ·5H ₂ O
1.98	42.35	"	2.98	42.69	"
1.56	47.09	"	1.85	45.04	CuSO ₄ ·H ₂ O
0.87	48.64	CuSO ₄ ·H ₂ O	0.55	52.39	"
0.10	59.64	"	0.08	64.16	"
0.18	68.88	"	0.22	71.89	" + CuSO ₄
0.33	70.25	" + CuSO ₄	0.08	72.62	CuSO ₄

The System CuSO₄ - H₂SO₄ - H₂O--Contd.

Results at 0°
(Engel, 1887)

Results at 12°
(Foote, 1919)

Gms. per 100 Grams H ₂ O			Gms. per 100 gms. sat. sol.		Solid Phase
Density	H ₂ SO ₄	CuSO ₄	CuSO ₄	H ₂ SO ₄	
1.144	0	14.85			
1.143	2.03	14.29			
1.158	7.16	12.45			
1.170	15.20	9.90	16.15	0.0	CuSO ₄ ·5H ₂ O
1.195	26.57	6.43	1.67	51.5	" + CuSO ₄ ·3H ₂ O
1.211	27.57	6.19	0.81	61.54	CuSO ₄ ·H ₂ O + "
1.224	35.2	3.99			

(Cont.)

Cu CUPRUM

Results at 22°

[Including part of the basic region of the system $\text{CuO} - \text{SO}_3 - \text{H}_2\text{O}$ where the saturating phase is $\text{CuSO}_4 \cdot 3\text{Cu}(\text{OH})_2 \cdot \text{H}_2\text{O}$]
(Binder, 1936)

	Gm. Mols. per 100 gm. Mols. $\text{CuO} + \text{SO}_3 + \text{H}_2\text{O}$		Solid Phase	Gm. Mols. per 100 gm. Mols. $\text{CuO} + \text{SO}_3 + \text{H}_2\text{O}$		Solid Phase
	CuO	SO_3		CuO	SO_3	
30	0.52	0.50	$4\text{CuO} \cdot \text{SO}_3 \cdot 4\text{H}_2\text{O}$	4.92	17.54	$\text{CuO} \cdot \text{SO}_3 \cdot 5\text{H}_2\text{O}$
	1.24	1.22	"	4.08	20.09	"
	1.55	1.52	"	3.07	24.26	"
	1.68	1.80	"	2.09	22754	"
	3.69	3.78	"	1.26	34.30	"
	5.05	5.15	"	1.23	40.25	"
	7.04	7.19	"	1.12	44.08	$\text{CuO} \cdot \text{SO}_3 \cdot 3\text{H}_2\text{O}$
	8.12	8.20	"	0.82	45.16	"
	8.77	8.92	" + $\text{CuO} \cdot \text{SO}_3 \cdot 5\text{H}_2\text{O}$	0.73	48.31	"
	7.59	10.95	$\text{CuO} \cdot \text{SO}_3 \cdot 5\text{H}_2\text{O}$	0.08	54.22	"
	7.87	11.32	"	0.07	63.24	"
	7.26	12.03	"	0.09	72.00	" + $\text{CuO} \cdot \text{SO}_3$
	6.53	13.21	"	0.12	72.52	$\text{CuO} \cdot \text{SO}_3$
	5.72	15.23	"	0.19	76.52	"

The author also made determinations at 100° which agree in general with those of Posnjak and Tunell, 1929, at that temp.

Results at 25°

(Bell and Taber, 1908; Foote, 1915, 1919)

	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	H_2SO_4	CuSO_4		H_2SO_4	CuSO_4	
	0	18.47	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	55.72	2.13	$\text{CuSO}_4 \cdot 3\text{H}_2\text{O} + \text{CuSO}_4 \cdot \text{H}_2\text{O}$
	11.14	12.62	"	61.79	0.95	$\text{CuSO}_4 \cdot \text{H}_2\text{O}$
	25.53	5.92	"	77.93	0.17	"
	36.77	3.25	"	83.29	0.15	"
	42.15	2.63	"	85.46	0.19	"
	47.66	2.59	"	85.76	0.43	" + CuSO_4
	49.20	2.83	" + $\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$	86.04	0.40	CuSO_4
	50.23	2.70	$\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$	92.70	0.19	"
	54.78	2.19	"			

(Goodwin and Horsch, 1919)

$d_{25}^{\text{sat. sol.}}$	Gram. Equivalents per liter		$d_{25}^{\text{sat. sol.}}$	Gram. Equivalents per liter	
	CuSO_4	H_2SO_4		CuSO_4	H_2SO_4
1.2140	2.818	0.0000	1.2165	2.181	1.876
1.2104	2.784	0.1488	1.2162	2.153	1.914
1.2070	2.634	0.4208	1.2229	1.837	3.077
1.2115	2.457	0.8680	1.2267	1.649	3.659
1.2130	2.320	1.3450			

(Cont.)

THE BASIC REGION OF THE SYSTEM $\text{CuO} - \text{SO}_3 - \text{H}_2\text{O}$ AT 25°
(Britton, 1925)

Quantities of amorphous basic sulfate of copper were suspended in aqueous solutions containing different amounts of copper sulfate and sulfuric acid. The mixtures were kept in a thermostat and shaken daily for about a week and the solutions and air dried solid phases were analyzed. After an additional period of 2 to 3 months they were again analyzed. Less than a week was sufficient for equilibrium. In the most basic part of the isotherm it was necessary to use hydrated copper oxide. The terms in which the results are expressed are not clearly defined.

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Liquid Phase		Solid Phase
% CuO	% SO_3	
0.0	0.0	$4\text{CuO} \cdot \text{SO}_3 \cdot 5\text{H}_2\text{O} + \text{CuO (hydrated)}$
0.02	0.02	$4\text{CuO} \cdot \text{SO}_3 \cdot 4\text{H}_2\text{O}$
0.09	0.09	"
0.12	0.12	"
0.58	0.58	"
3.17	3.19	"
5.54	5.56	"
7.17	7.18	"
9.28	9.33 (Eutec.)	" + $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Results at 30°

(Cameron and Crockford, 1929)

Gms. per 100 gms. H_2O

H_2SO_4	CuSO_4
7.38	20.14
17.13	18.62
20.65	16.22
27.76	14.08
49.61	7.82

Cu CUPRUM

EQUILIBRIUM IN THE SYSTEM COPPER OXIDE, SULFUR TRIOXIDE
AND WATER AT 50°, 100° and 200°

[Including Basic Regions]

(Posnjak and Tunell, 1929; Tunell and Posnjak, 1931)

Results at 50°

Results at 100°

S ₀	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CuO	SO ₃		CuO	SO ₃	
0.00	0.002		CuO + 4.1.3	0.001	0.002	CuO + 4.1.3
0.05	0.05		4.1.3	0.008	0.009	3.1.2 + "
0.13	0.13		"	0.02	0.02	" "
1.65	1.68		"	0.38	0.40	3.1.2
3.54	3.58		" + 3.1.2	1.16	1.24	"
7.53	7.57		3.1.2	3.69	3.87	"
8.98	9.06		"	4.56	4.72	"
10.98	11.08		"	5.61	5.81	"
12.44	12.52		" + 1.1.5	8.62	8.69	"
9.34	16.12		1.1.5	14.57	14.82	"
4.74	29.28		"	21.07	21.44	" + 3.2.5
3.83	34.46		"	21.14	21.52	3.2.5
3.6	37.5		" + 1.1.3	21.37	21.74	" + 1.1.3
3.28	38.5		1.1.3	17.92	22.73	1.1.3
2.1	40.0		" + 1.1.1	15.89	25.44	"
2.35	43.04		1.1.1	12.60	31.40	" + 1.1.1
1.54	45.40		"	10.49	33.67	1.1.1
1.09	47.43		"	2.92	45.04	"
0.23	56.81		"	1.64	49.20	"
0.16	71.42		"	0.84	53.60	"
0.17	72.40		" + 1.1	0.2	70.6	" + 1.1

Results at 200°

0.02	0.05	3.1.2	18.72	21.65	1.1.1
0.17	0.30	"	14.36	30.99	"
2.37	2.96	"	13.36	33.36	"
4.57	5.58	"	8.21	43.62	"
8.58	10.08	"	6.35	45.81	"
11.93	13.03	"	2.14	65.48	"
17.16	18.94	"	2.0	67	" + 1.1
18.46	19.83	" + 1.1.1	1.0	70	1.1

4.1.3 = $4\text{CuO} \cdot \text{SO}_3 \cdot 3\text{H}_2\text{O}$; 3.1.2 = $3\text{CuO} \cdot \text{SO}_3 \cdot 2\text{H}_2\text{O}$; 1.1.5 = $\text{CuO} \cdot \text{SO}_3 \cdot 5\text{H}_2\text{O}$;
 1.1.3 = $\text{CuO} \cdot \text{SO}_3 \cdot 3\text{H}_2\text{O}$; 1.1.1 = $\text{CuO} \cdot \text{SO}_3 \cdot \text{H}_2\text{O}$; 1.1 = $\text{CuO} \cdot \text{SO}_3$; 3.2.5 =
 $3\text{CuO} \cdot 2\text{SO}_3 \cdot 5\text{H}_2\text{O}$.

BASIC COPPER SULFATES

SO

For data on the basic region of the system $\text{CuO} - \text{SO}_3 - \text{H}_2\text{O}$ see also pp 970-2.

EQUILIBRIUM IN THE SYSTEM $\text{CuO} + \text{CuSO}_4 + \text{H}_2\text{O}$ AT 18°
(Gromov, 1948)

CuSO_4 Wt. %	Gms. Cu per liter	Density	pH	Solid Phase
17.4	82.8	1.196	3.80	$3\text{CuO} \cdot \text{CuSO}_4 \cdot x\text{H}_2\text{O} + \text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
8.8	39.1	1.119	4.07	$3\text{CuO} \cdot \text{CuSO}_4 \cdot \text{H}_2\text{O}$
5.87	24.8	1.060	4.17	"
4.29	17.4	1.038	4.22	"
1.55	6.2	1.014	4.31	"
0.68	2.7	1.007	4.41	"
0.40	1.6	1.004	4.45	"
0.19	0.72	1.002	4.96	"
0.14	0.55	1.001	5.04	"
0.10	0.38	1.001	5.24	"
0.025	0.10	1.000	5.80	"
0.0	0.0	1.000	6.2	Not determined

SOLUBILITY OF $5\text{Cu}(\text{OH})_2 \cdot \text{CuSO}_4$ IN AQUEOUS AMMONIA SOLUTIONS AT 20°
(Archipov and Paksver, 1939)

Added Solute	Gms. Cu per liter	Added Solute	Gms. Cu per liter
None	32.6	Na_2SO_4	34.67
Glucose	39.6	Tartaric Acid	43.0
NH_4Cl	38.06	Pyridine	29.43
NaCl	34.4	Cu_2Cl_2	36.2

The authors shook 10 gms. of $5\text{Cu}(\text{OH})_2 \cdot \text{CuSO}_4$ with varying amounts of an 18% NH_3 solution, and determined the concentration of the copper in each solution:

ml. 18% NH_3 Added to 10 gms. of Basic Salt	Gms. Cu per liter
100	30.22
167	24.70
200	23.20
500	12.10

The solubility product of $\text{CuSO}_4 \cdot 3\text{Cu}(\text{OH})_2$ at 25° in potassium sulfate solutions was determined by Nasanen and Tasminen, 1949, and Nasanen, 1942a.

Cu CUPRUM

EQUILIBRIUM IN THE SYSTEM $\text{CuO} + \text{CuSO}_4 + \text{ZnO} + \text{ZnSO}_4 + \text{H}_2\text{O}$ AT 18°
(Cromov, 1948)

Gms. Zn per liter	Gms. Cu per liter	pH	Solid Phase
185.3	0.38	5.30	$3\text{ZnO} \cdot \text{ZnSO}_4 \cdot x\text{H}_2\text{O} + 3\text{CuO} \cdot \text{CuSO}_4 \cdot x\text{H}_2\text{O}$
144.5	.28	5.44	"
108.5	.17	5.55	"
70.5	.12	5.70	"
53.0	.083	5.80	"
30.3	.045	6.05	"
SO 16.6	Slight	6.18	"
9.4	-	6.31	"

SOLUBILITY OF COPPER SULFATE IN AMMONIA SOLUTION

A solution of CuSO_4 in 13.15% NH_3 contains 66.5 gms. Cu per liter at 20°, - Archipov and Paksver, 1939.

THE SYSTEM COPPER SULFATE - COPPER CHLORIDE - WATER AT 30°
(Schreinemakers, 1910)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
CuCl_2	CuSO_4		CuCl_2	CuSO_4	
0	20.32	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	39.48	3.21	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
6.58	13.62	"	42.62	2.90	" + $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
15.68	8.93	"	43.25	1.14	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
25.67	4.77	"	43.95	0	"

**DATA FOR EQUILIBRIUM IN COMPLEX SYSTEMS CONTAINING
COPPER SULFATE AND COPPER CHLORIDE**

System	Authority
$\text{CuSO}_4 + \text{CuCl}_2 + (\text{NH}_4)_2\text{SO}_4 + \text{NH}_4\text{Cl} + \text{H}_2\text{O}$	(Schreinemakers, 1910)
" + " + $\text{K}_2\text{SO}_4 + \text{KCl} + \text{H}_2\text{O}$	(Schreinemakers and de Baat, 1914a)
" + " + $\text{Na}_2\text{SO}_4 + \text{NaCl} + \text{H}_2\text{O}$	(Schreinemakers, 1911)

THE SYSTEM COPPER SULFATE - FERROUS SULFATE - WATER
(Agde and Barkholt, 1926)

Similar determinations are also given at 10°, 15°, 20°, 30°, 35° and 40°. Saturation was, in general, approached from above. The mixtures were stirred constantly and protected from the air by means of a mercury seal.

Results at 25°

d of sat. sol.	Gms. per 100 gms. sat. sol.		d of sat. sol.
	CuSO ₄ ·5H ₂ O	FeSO ₄ ·7H ₂ O	
1.256	28.64	5.03	1.357
1.275	28.87	7.08	1.383
1.320	28.26	12.46	1.408
1.320	27.44	15.09	1.469
1.343	27.62	17.65	1.537
1.314	23.23	18.68	1.512
1.308	22.09	20.28	1.505
1.308	19.78	23.05	1.482
1.305	19.84	22.29	1.472
1.300	14.96	27.56	1.477
-	14.64	28.40	1.470
1.291	12.18	29.84	1.460
1.289	10.76	31.39	1.450
1.275	5.52	36.29	1.457
1.266	3.88	37.45	1.437

Results at 56°

d of sat. sol.	Gms. per 100 gms. sat. sol.		d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase at both temperatures
	CuSO ₄ ·5H ₂ O	FeSO ₄ ·7H ₂ O		CuSO ₄ ·5H ₂ O	FeSO ₄ ·7H ₂ O	
1.256	28.64	5.03	1.357	41.92	4.50	CuSO ₄ ·5H ₂ O
1.275	28.87	7.08	1.383	41.61	6.28	"
1.320	28.26	12.46	1.408	41.10	10.12	"
1.320	27.44	15.09	1.469	41.24	17.90	"
1.343	27.62	17.65	1.537	39.31	26.55	"
1.314	23.23	18.68	1.512	31.15	34.07	FeSO ₄ ·7H ₂ O
1.308	22.09	20.28	1.505	27.62	37.92	"
1.308	19.78	23.05	1.482	21.25	43.49	"
1.305	19.84	22.29	1.472	19.52	45.00	"
1.300	14.96	27.56	1.477	19.81	45.04	"
-	14.64	28.40	1.470	15.01	50.31	"
1.291	12.18	29.84	1.460	11.95	52.95	"
1.289	10.76	31.39	1.450	10.73	54.65	"
1.275	5.52	36.29	1.457	5.35	60.21	"
1.266	3.88	37.45	1.437	3.80	60.48	"

30

The following additional determinations for this system at 30° are given by Cameron and Crockford, 1929. See also Eckstein and Lissner, 1954.

Gms. per 100 gms. H ₂ O		Solid Phase	Gms. per 100 gms. H ₂ O		Solid Phase
CuSO ₄	FeSO ₄		CuSO ₄	FeSO ₄	
23.53	3.13	CuSO ₄ ·5H ₂ O	20.67	11.82	CuSO ₄ ·5H ₂ O
21.98	3.29	"	20.54	17.16	" + Solid Solution
21.56	6.86	"	18.95	19.61	Solid Solution
22.49	11.51	"	16.02	22.75	" "

THE SYSTEM COPPER SULFATE - FERROUS SULFATE - SULFURIC ACID - WATER
Results of Cameron and Crockford, 1929 at 30°

The mixtures were prepared by adding in some cases an excess of ferrous sulfate to aqueous solutions of cupric sulfate and in others an excess of cupric sulfate to aqueous solutions of ferrous sulfate. An equal excess of sulfuric acid was added to each of these and the mixtures so prepared were kept in a thermostat at 30° and frequently shaken during about three weeks. The analyses of the solutions and solid phases gave very irregular results indicating that equilibrium had not been reached. The solid phase contained both CuSO₄ and FeSO₄ in all cases with variable

Cu CUPRUM

amounts of H_2SO_4 and H_2O . If the authors' results are arranged in the order of increasing percentage of H_2SO_4 in solution it will be noted that the sum of the $\text{CuSO}_4 + \text{FeSO}_4$ diminishes with increasing concentration of H_2SO_4 .

	Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
	H_2SO_4	CuSO_4	FeSO_4	$\text{CuSO}_4 + \text{FeSO}_4$	H_2SO_4	CuSO_4	FeSO_4	$\text{CuSO}_4 + \text{FeSO}_4$
50	0.0	20.54	17.16	37.70	5.71	16.05	2.09	18.14
	4.51	16.21	7.17	23.38	6.16	15.40	3.58	18.98
	4.50	13.22	12.09	25.31	6.21	18.36	3.63	21.99
	4.58	13.99	11.32	24.31	7.62	13.93	5.39	19.32
	4.69	13.82	11.24	25.06	9.46	9.17	9.68	18.85
	5.06	13.38	11.62	24.00	11.13	3.44	11.33	14.77
	5.50	11.09	13.55	24.64	11.35	5.86	10.40	16.26
	5.38	13.67	11.09	24.76	12.49	1.91	12.41	13.32
	5.49	13.89	10.85	24.74				

Results of Mazover, 1953
Solubility of $(\text{Cu}, \text{Fe})\text{SO}_4 \cdot 5\text{H}_2\text{O}$ solid solutions in aq. H_2SO_4
[Solid phase $(\text{Cu}, \text{Fe})\text{SO}_4 \cdot 5\text{H}_2\text{O}$]

A series of data at these temperatures showing the quantity of FeSO_4 in the solid solutions (0 - 10%) as a function of acid concentration is also given.

Gms. per liter sat. sol.				Gms. per liter sat. sol.			
H ₂ SO ₄	FeSO ₄	CuSO ₄	Density	H ₂ SO ₄	FeSO ₄	CuSO ₄	Density
Results at 27°				Results at 48°--Contd.			
7.5	15.73	226.1	1.1462	33.6	10.78	278.0	1.2733
	33.70	219.1	1.1517		71.00	271.0	1.3437
	56.90	219.1	1.2003		155.50	234.0	1.3277
22.8	12.82	217.0	1.1751	189.00	214.2	1.300	
	34.45	214.3	1.2051	215.80	199.3	1.2632	
	57.40	212.8	1.2469				
	99.50	201.0	1.2835				
	123.30	183.5	1.2556				
35.7	185.80	151.0	1.2412				
	22.80	207.8	1.2135	7.5	13.15	342.0	1.3167
	130.00	170.5	1.2744	23.6	10.42	336.5	1.3227
	171.50	154.9	1.2839		30.40	334.0	1.3433
	189.00	133.0	1.2401		51.70	330.5	1.3581
Results at 48°					153.00	293.2	1.3898
7.7	20.95	292.0	1.2752	33.1	43.70	325.5	1.3749
	12.05	286.0	1.2475		75.60	322.0	1.4317
	33.80	285.5	1.2779		112.20	302.7	1.3884
	55.75	282.0	1.3052		140.50	286.9	1.3890
	114.50	264.0	1.3217		189.00	264.0	1.3810
21.9	163.00	242.0	1.3071		204.50	256.5	1.3812

(Cont.)

Gms. per liter sat. sol.				Gms. per liter sat. sol.			
H ₂ SO ₄	FeSO ₄	CuSO ₄	Density	H ₂ SO ₄	FeSO ₄	CuSO ₄	Density
Results at 76°				Results at 95°			
7.4	21.50	430.5	1.3890	7.0	43.70	548.5	1.4676
	54.60	420.0	1.3966		59.50	543.0	1.4820
20.1	10.20	423.0	1.3875		74.70	542.5	1.4902
	38.40	416.0	1.4066	19.4	30.60	545.5	1.4821
21.1	73.30	405.0	1.4204		71.10	534.0	1.5054
	115.50	392.5	1.4361		109.90	520.0	1.5227
	148.30	375.5	1.4280		153.50	494.0	1.5194
	172.60	362.0	1.4200	30.3	10.60	541.5	1.4761
	194.60	380.0	1.4099		58.30	530.0	1.5244
34.5	26.20	414.0	1.4259		90.80	523.5	1.5397
	56.95	406.0	1.4156		122.20	507.0	1.5464
					143.30	494.5	1.5624
					184.80	474.0	1.5600
					231.50	445.5	1.5472

EQUILIBRIUM IN THE SYSTEM CUPRIC OXIDE, FERRIC OXIDE, SULFUR
TRIOXIDE AND WATER AT 50°
(Tunell and Posnjak, 1931)

The purpose of this study was to gain some knowledge of the changes which occur during the natural oxidation of the iron and copper sulfide ore bodies in altered porphyry. Mixtures of known composition were sealed in glass tubes and there kept at 50° and shaken daily for from one to three years. The mixtures contained in all cases 93.5 per cent or more of water and 6.5 per cent or less of each of the other constituents. The five crystalline solid phases which were formed, namely, Fe₂O₃·H₂O (Goethite), 3Fe₂O₃·4SO₃·9H₂O, CuO (Tenorite), 4CuSO₄·3H₂O (Brochantite), and 3CuSO₄·2H₂O (Antherite) were identified analytically and by optical properties and X-ray diffraction patterns. No double salt was formed in this limited portion of the system.

For data on the system CuSO₄ + FeSO₄ + ZnSO₄ + H₂SO₄ + H₂O at 27°, 48° and 59° (Cu, Fe, Zn pentahydrated solid solutions are formed), see Mazover, 1953.

Results for a portion of the system CuSO₄ + FeSO₄ + NiSO₄ + H₂O from 15° to 70° are presented diagrammatically by Eckstein and Lissner, 1954.

THE SYSTEM COPPER SULFATE - POTASSIUM SULFATE - WATER
(Caven and Mitchell, 1924)

The mixtures were kept in a thermostat and shaken intermittently. The solutions were analyzed repeatedly until concordant results were obtained. Further data at 25° are given by Ricci and Fischer, 1952 who point out the difficulties in determining a mixed total sulfate. See also Meerberg, 1909.

Cu CUPRUM

THE SYSTEM COPPER SULFATE - POTASSIUM SULFATE - WATER--Contd.

Results at 25°

Mols. per 100 gms. H ₂ O		Solid Phase	Mols. per 100 gms. H ₂ O		Solid Phase
CuSO ₄	K ₂ SO ₄		CuSO ₄	K ₂ SO ₄	
0.1410	0.00	CuSO ₄ ·5H ₂ O	0.0955	0.0270	1.1.6
0.1415	0.0014	"	0.0365	0.0331	"
0.1430	0.0037	"	0.0350	0.0350	"
0.1457	0.0086	"	0.0237	0.0412	"
0.1477	0.0110	"	0.0120	0.0598	"
0.1504	0.0150	"	0.0092	0.0737	" + K ₂ SO ₄
0.1570	0.0225	" + 1.1.6	0.0060	0.0708	K ₂ SO ₄
0.1525	0.0228	1.1.6	0.0000	0.0661	"
0.1145	0.0261	"			

Results at 51°

Results at 61°

0.2073	0.00	CuSO ₄ ·5H ₂ O	0.2419	0.00	CuSO ₄ ·5H ₂ O
0.2266	0.0618	" + 1.1.6	0.2586	0.0838	" + 1.1.6
0.0677	0.0706	1.1.6	0.0728	0.0932	1.1.6
0.0312	0.1036	" + K ₂ SO ₄	0.0422	0.1187	" + K ₂ SO ₄
0.0000	0.0923	K ₂ SO ₄	0.000	0.1064	K ₂ SO ₄

1.1.6 = CuSO₄·K₂SO₄·6H₂OSO COPPER POTASSIUM SULFATE CuSO₄·K₂SO₄·6H₂OSOLUBILITY IN WATER
(Lattey, 1923)

t°	Gms. CuSO ₄ ·K ₂ SO ₄ per 100 gms. sat. sol.	Solid Phase
0	4.84	CuSO ₄ ·K ₂ SO ₄ ·6H ₂ O
6.8	5.93 ^a	"
10	6.71	"
15	7.84	"
20	9.09	"
25	10.47	"
	10.47 ^b	"
	10.35 ^c	"
30	11.97	"
40	15.37	"

^aPloin, 1926^bLocke, 1902^cHill, Durham and Ricci, 1940 (density 25° = 1.094)

THE SYSTEM $\text{CuK}_2(\text{SO}_4)_2 - \text{CoK}_2(\text{SO}_4)_2 - \text{H}_2\text{O}$

[Continuous hexahydrated solid solutions are formed]

(Floinn, 1926)

Results at 0°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase	
	$\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{CoSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$		
1.0462	67.67	0.00	100.00	30
1.0488	58.33	13.46	89.04	
1.0524	53.71	22.09	81.60	
1.0538	46.32	33.30	69.67	
1.0566	39.48	44.15	58.74	
1.0601	31.19	56.68	49.46	
1.0612	25.43	65.31	40.85	
1.0673	11.40	87.06	21.41	
1.0719	0.00	106.81	0.00	

Results at 7.8°

1.0587	85.99	0.00	100.00
1.0617	74.48	17.21	87.78
1.0639	66.14	29.49	79.89
1.0668	56.02	44.02	70.84
1.0703	46.92	58.54	59.53
1.0730	37.08	73.90	47.13
1.0760	32.18	82.36	41.27
1.0796	25.30	94.53	29.75
1.0825	14.59	110.20	20.40
1.0852	5.90	124.47	9.56
1.0879	0.00	113.80	0.00

THE SYSTEM $\text{CuK}_2(\text{SO}_4)_2 - \text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 - \text{H}_2\text{O}$

(Results of Fock, 1897 at 13-14°)

[Continuous hexahydrated solid solutions are formed]

Mols. per 100 Mols. H_2O		Mol. per cent K Salt	
K Salt	NH_4 Salt	in Solution	in Solid
0	1.035	0	0
0.0897	0.8618	5.06	10.34
0.2269	0.6490	16.76	33.05
0.2570	0.5887	30.40	46.22
0.2946	0.5096	36.63	58.20
0.3339	0.3319	50.15	75.34
0.4560	0.1961	69.93	83.86
0.4374	0	100	100

Cu CUPRUM

THE SYSTEM $\text{CuK}_2(\text{SO}_4)_2 + \text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$ (Cont.)
(Results of Hill, Durham, and Ricci, 1940 at 25°)

NOTE: Each point was determined in duplicate, reversing the order of addition of the salts, in order to assure the attainment of equilibrium. Continuous solid solutions containing six molecules of water were formed in each case.

	Saturated Solution		Solid Phase	
	Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2$	Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2$
	0.0	18.60	-	-
	2.03	15.44	16.35	57.01
	3.28	13.49	26.90	46.92
	5.45	10.04	42.78	31.62
30	6.87	7.35	54.31	20.60
	8.55	3.90	66.12	9.01
	10.35	0.0	-	-

THE SYSTEM $\text{CuK}_2(\text{SO}_4)_2 + \text{ZnK}_2(\text{SO}_4)_2 + \text{H}_2\text{O}$

Results of Hill, Durham and Ricci at 25°

(See note, above)

Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{ZnK}_2(\text{SO}_4)_2$	Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{ZnK}_2(\text{SO}_4)_2$
0.0	11.72	-	-
1.303	10.37	9.61	66.17
3.010	8.53	22.68	52.87
4.74	6.64	36.30	39.25
6.42	4.74	49.44	26.08
8.22	2.617	62.81	12.68
10.35	0.0	-	-

Results of Ploin, 1926 at 6.8°

<u>d</u> of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{ZnSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.0581	85.32	0.00	100.00
1.0595	75.83	12.11	87.82
1.0620	68.79	22.53	77.17
1.0634	58.14	34.58	66.05
1.0644	49.28	45.55	55.55
1.0658	42.93	54.10	45.64
1.0672	33.40	65.60	36.81
1.0682	24.74	75.91	27.64
1.0690	16.99	84.80	18.69
1.0707	0.00	106.08	0.00

THE SYSTEM COPPER POTASSIUM SULFATE - NICKEL POTASSIUM
SULFATE - WATER
(Data of Halpern, 1926)

Results at 0°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{NiSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.0466	70.71	0.00	100.00
1.0456	65.45	3.04	88.88
1.0454	57.00	9.43	77.98
1.0433	53.04	11.52	69.02
1.0434	45.85	15.83	54.56
1.0395	37.39	21.37	45.22
1.0393	27.89	28.50	32.39
1.0357	14.70	37.64	14.05
1.0224	0.00	48.07	0.00

30

Results at 8.5°

1.0582	92.12	0.00	100.00
1.0281	79.73	6.47	80.46
1.0563	69.71	13.53	71.41
1.0521	60.13	20.53	61.12
1.0547	55.38	21.29	47.98
1.0496	43.51	29.61	39.83
1.0472	35.60	33.79	29.34
1.0426	24.46	39.13	21.07
1.0451	15.36	47.85	12.32
1.0397	0.00	60.18	0.00

THE SYSTEM $\text{CuK}_2(\text{SO}_4)_2 + \text{NiK}_2(\text{SO}_4)_2 + \text{H}_2\text{O}$ AT 25°
(Data of Hill, Durham and Ricci, 1940)

Note: Each point was determined in duplicate, reversing the order of addition of the salts.

Results at 25°

Saturated Solution		Solid Phase	
Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{NiK}_2(\text{SO}_4)_2$	Wt. % $\text{CuK}_2(\text{SO}_4)_2$	Wt. % $\text{NiK}_2(\text{SO}_4)_2$
10.35	0.0	-	-
9.26	0.71	61.77	13.86
7.84	1.507	44.91	30.51
6.56	2.220	33.11	42.26
5.07	3.082	22.24	53.20
2.981	4.34	10.81	64.49
0.0	6.33	-	-

(Cont.)

Cu CUPRUM

THE SYSTEM COPPER SULFATE - AMMONIUM SULFATE - WATER

Results at 0°
(Engel, 1886)Results at 30°
(Schreinemakers, 1910)

Sp. Gr. of Solutions	Grams per 100 cc Solution		Gms. per 100 Gms. Sat. Solution		Solid Phase
	(NH ₄) ₂ SO ₄	CuSO ₄	(NH ₄) ₂ SO ₄	CuSO ₄	
1.144	0.0	14.79	44.	0	(NH ₄) ₂ SO ₄
1.190	3.61	16.09	38.32	0.77	(NH ₄) ₂ SO ₄ + 1.1.6
1.108	4.63	8.38	29.27	1.57	1.1.6
1.099	4.90	7.26	17.53	4.05	"
1.0815	5.59	5.13	*9.33	11.03	"
1.071	7.51	2.95	8.19	13.65	"
1.082	12.31	0.94	6.08	16.77	"
1.116	20.65	0.80	5.79	20.53	1.1.6 + CuSO ₄ ·5H ₂ O
			2.45	20.19	CuSO ₄ ·5H ₂ O
			0	20.32	"

Results at 10°

Some data are given by Rüdorff
(1873), and by Schiff (1859).* = Solubility of 1.1.6 in water.
1.1.6 = CuSO₄(NH₄)₂SO₄·6H₂O.Results at 25°, 51° and 61°
(Caven and Mitchell, 1924)Further data at 25° are given by Ricci and Fischer 1952 who point
out the errors involved in a mixed total sulfate determination.

t°	Mols. per 100 gms. H ₂ O		Solid Phase
	CuSO	(NH ₄) ₂ SO ₄	
25	0.0	0.5801	(NH ₄) ₂ SO ₄
25	0.0042	0.5762	" + 1.1.6
25	0.0070	0.3826	1.1.6
25	0.0112	0.3233	"
25	0.0507	0.0989	"
25	0.0779	0.0779	"
25	0.1259	0.0601	"
25	0.1413	0.0572	"
25	0.1646	0.0534	" + CuSO ₄ ·5H ₂ O
25	0.1558	0.0293	CuSO ₄ ·5H ₂ O
25	0.1494	0.0158	"
25	0.1470	0.0096	"
51	0.90	0.6462	(NH ₄) ₂ SO ₄
51	0.180	0.6733	" + 1.1.6
51	0.1302	0.1351	1.1.6
51	0.2365	0.0861	" + CuSO ₄ ·5H ₂ O
51	0.2073	0.0000	CuSO ₄ ·5H ₂ O
61	0.000	0.6714	(NH ₄) ₂ SO ₄
61	0.0249	0.7079	" + 1.1.6
61	0.0396	0.6387	1.1.6
61	0.1631	0.1695	"
61	0.2753	0.0998	" + CuSO ₄ ·5H ₂ O
61	0.2419	0.000	CuSO ₄ ·5H ₂ O

1.1.6 = (NH₄)₂SO₄·CuSO₄·6H₂O

Data for equilibrium in the quarternary system $(\text{NH}_4)_2\text{SO}_4 + \text{CuSO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$ at 25° are given by Hayami, 1921; and by Janecke, 1938. Data for the System $\text{CuSO}_4 + (\text{NH}_4)_2\text{SO}_4 + \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$ are given by Schreinemakers, 1909.

COPPER AMMONIUM SULFATE $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$

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SOLUBILITY IN WATER

The determinations of Lattey, 1923 from 0° - 100° show the change in solubility with temperature, but where comparison is possible (below 40°), the data lie below those of other investigators.

Solid Phase $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ throughout

Gms. $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$			Gms. $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$		
t°	per 100 gms. sat. sol.	Density	t°	per 100 gms. sat. sol.	Density
0	10.27	-	25	18.58 ^f	-
	10.41 ^c	1.095		18.60 ^e	1.160
	10.49 ^a	1.093	30	19.64	-
6.8	12.21	1.109		20.36 ^d	-
7	12.10 ^a	1.113	40	23.34	-
8	12.54 ^{ab}	1.111	50	27.34	-
	12.41 ^c	1.112	60	31.63	-
10	13.10	-	70	36.21	-
15	14.63	-	80	41.08	-
20	16.22	-	90	46.25	-
25	17.89	-	100	51.71	-

^aBertisch, 1926

^bHaber-Chuwis, 1926

^cOstersetzer, 1926

^dSchreinemakers, 1910

^eHill, Durham and Ricci, 1940

^fHill and Taylor, Jr., 1936

THE SYSTEM COPPER AMMONIUM SULFATE - COBALT AMMONIUM SULFATE - WATER
(Bertisch, 1926)

Results at 0°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent in Solid Phase
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{CoSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.0931	162.82	0.00	100.00
1.0905	138.11	15.79	85.73
1.0886	127.89	22.56	75.87
1.0863	110.93	35.53	67.10
1.0836	92.28	49.49	56.78
1.0809	80.87	56.92	47.14
1.0758	50.70	77.68	30.86
1.0687	16.14	101.36	9.94
1.0646	0.00	111.65	0.00

(Cont.)

Cu CUPRUM

THE SYSTEM COPPER AMMONIUM SULFATE - COBALT AMMONIUM SULFATE - WATER-Contd.

Results at 8°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{CoSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.1112	197.62	0.00	100.00
1.1094	178.04	12.09	90.57
1.1059	157.65	28.44	81.56
1.1027	144.14	34.93	74.09
1.0985	120.61	51.75	63.59
SO 1.0960	96.99	69.22	51.24
1.0923	82.50	77.75	42.09
1.0846	40.45	105.76	22.71
1.0757	27.76	112.79	14.32
1.0757	0.00	130.78	0.00

**THE SYSTEM COPPER AMMONIUM SULFATE -
IRON AMMONIUM SULFATE - WATER
(Haber-Chuwis, 1926)**

d of sat. sol.	Gms. per 1000 cc sat. sol.		Mol. per cent $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.1020	163.92	0.00	100.00
1.1032	151.88	18.17	92.82
1.1069	131.14	47.52	82.40
1.1105	110.43	78.30	69.63
1.1175	93.50	104.30	59.30
1.1218	79.41	125.98	49.08
1.1260	61.39	153.09	37.91
1.1369	34.49	199.69	29.12
1.1392	0.00	245.32	0.00

Results at 8.2°

1.1178	197.58	0.00	100.0
1.1202	173.56	31.95	89.43
1.1245	160.29	52.61	81.77
1.1287	141.70	79.28	72.65
1.1331	119.77	110.95	59.83
1.1366	98.70	140.93	48.80
1.1410	62.44	191.76	31.64
1.1448	50.42	208.84	25.47
1.1495	32.07	233.63	16.58
1.1538	17.03	256.05	8.78
1.1562	0.00	279.68	0.00

THE SYSTEM COPPER AMMONIUM SULFATE - MAGNESIUM AMMONIUM
SULFATE - WATER AT 25°
(Hill, Durham, and Ricci, 1940)

Each determination was done in duplicate, and the order of addition of the salts was reversed, in order to assure the attainment of equilibrium.

Saturated Solution		Solid Phase	
Wt. % $\text{Cu}(\text{NH}_4)_2\text{SO}_4$	Wt. % $\text{Mg}(\text{NH}_4)_2\text{SO}_4$	Wt. % $\text{Cu}(\text{NH}_4)_2\text{SO}_4$	Wt. % $\text{Mg}(\text{NH}_4)_2\text{SO}_4$
0.0	16.61	-	-
3.46	13.73	14.88	55.82
6.47	11.14	28.67	42.54
8.65	9.16	38.53	33.16
12.44	5.76	53.94	18.29
15.88	2.63	65.25	6.81
18.60	0.0	-	-

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THE SYSTEM COPPER AMMONIUM SULFATE - MANGANESE
AMMONIUM SULFATE - WATER AT 7°
(Bertisch, 1926)

d of sat. sol.	Gms. per 1000 cc sat. solution		$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase	
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{MnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	Wt. per cent	Mol. per cent
1.1129	192.36	0.00	100.00	100.00
1.1179	162.83	43.93	93.28	93.15
1.1143	143.75	81.27	85.23	84.96
1.1349	116.69	126.64	75.93	75.53
1.1430	90.77	170.59	63.6	62.76
1.1576	68.58	232.19	53.37	51.83
1.1684	38.55	281.70	35.40	34.90
1.1787	28.39	312.03	24.68	24.28
1.1889	0.00	382.80	0.00	0.00

THE SYSTEM COPPER AMMONIUM SULFATE - NICKEL AMMONIUM SULFATE - WATER
Data of Ostersetzer, 1926

d of sat. sol.	Gms. per 1000 cc sat. sol.		$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase	
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	Wt. per cent at 0°	
1.0954	161.71	0.00	100.00	
1.0813	125.86	11.59	77.84	
1.0765	113.89	15.43	69.09	
1.0703	99.25	18.33	58.91	
1.0639	85.89	19.77	48.25	
1.0576	70.52	24.21	38.71	
1.0480	51.42	32.69	28.55	
1.0434	36.77	35.06	19.39	
1.0334	00.00	54.73	0.00	

(Cont.)

THE SYSTEM COPPER AMMONIUM SULFATE - NICKEL AMMONIUM
SULFATE - WATER--Contd.

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
at 8°			
1.1115	195.74	0.00	100.00
1.0937	150.12	13.25	76.70
1.0869	126.21	22.98	62.40
1.0784	110.71	23.47	52.36
1.0687	88.64	30.43	41.49
1.0631	70.23	37.70	32.23
1.0574	47.84	49.17	21.97
1.0506	33.65	51.74	15.25
1.0457	17.13	58.27	7.54
1.0404	0.00	67.13	0.00

Data of Fock 1897 at 13-14°

Note that the value for the solubility of $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2$ in water is lower than that found by other workers.

Mol. % in Solution		Mols. per 100 Mols. H_2O		Mol. % in Solid Phase	
Cu Salt	Ni Salt	Cu Salt	Ni Salt	Cu Salt	Ni Salt
0.0	100.0	0.0	0.521	0.0	100.0
33.34	66.66	0.01476	0.295	10.29	89.71
56.05	43.95	0.2664	0.2089	30.59	69.41
73.89	26.20	0.4165	0.1449	52.23	47.77
79.92	20.08	0.4785	0.1202	78.80	21.20
100.0	0.0	1.0350	0.0	100.0	0.0

Data of Hill and Taylor, Jr., 1938 at 25°

The determinations were made by a method insuring that equilibrium was attained. Duplicate samples were prepared for each ratio of the two double salts. In one case one of the two salts was dissolved completely and the second added in solid form. In the other the sequence was reversed. Thus equilibrium conditions in the solid solution of the two salts was approached from the two compositions of the two pure double salts. This method avoids the uncertainties of the results obtained in the majority of the investigations which have been made of such systems.

Wt. per cent composition of original complex		Wt. per cent composition of sat. solution	
$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$
-	0.0	18.58	0.0
17.89	2.29	15.81	0.64
17.08	5.43	14.60	0.90
13.78	5.74	12.60	1.44
9.00	6.21	8.87	2.50
4.29	6.67	4.28	4.58
0.0	-	0.0	7.09

Data of Hill and Taylor, Jr., 1938 at 25°--Cont.

Wt. per cent composition of solid phase

$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$
72.97	0.0
48.90	23.87
35.87	36.79
26.06	46.80
12.14	60.68
4.93	67.67
0.0	72.63

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THE SYSTEM COPPER AMMONIUM SULFATE - ZINC AMMONIUM SULFATE - WATER
Results at Halpern, 1926 at 6.8°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	$\text{ZnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	
1.1090	191.90	0.00	100.00
1.1033	158.06	22.27	83.24
1.0942	120.93	43.84	59.51
1.0934	108.48	50.64	52.28
1.0887	87.92	63.22	42.62
1.0847	69.82	73.62	32.36
1.0804	44.59	92.31	21.36
1.0755	11.09	113.69	6.11
1.0725	0.00	121.14	0.00

Results of Fock, 1897 at 13-14°

Note that the value for the solubility of $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2$ in water is lower than that found by other workers.

Mol. % in Solution		Mols. per 100 Mols. H_2O		Mol. % in Solid Phase	
Cu Salt	Zn Salt	Cu Salt	Zn Salt	Cu Salt	Zn Salt
4.97	95.03	0.0422	0.8069	2.39	97.61
10.65	89.35	0.0666	0.5638	4.52	95.48
19.24	80.76	0.1218	0.5115	90.3	90.97
30.19	69.81	0.2130	0.4924	14.67	85.33
44.44	55.56	0.3216	0.4022	22.62	77.38
100.0	0.0	1.035	0.0	100.0	0.0

Results of Hill and Taylor, Jr., 1938 at 25°

Wt. per cent composition of original complex		Wt. per cent composition of sat. solution	
$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{ZnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	$\text{ZnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$
-	0.0	18.58	0.0
17.51	3.80	14.75	2.39
16.07	9.55	11.99	4.13
11.51	10.39	9.84	5.75
8.53	10.81	7.82	6.78
4.23	11.53	4.28	9.22
0.0	-	0.0	12.24

Results of Hill and Taylor, Jr., 1938 at 25°--Contd.

Wt. per cent composition of solid phase

$\text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$		$\text{ZnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4$	
72.97		0.0	
51.75		21.08	
36.69		36.33	
25.05		48.00	
16.47		57.08	
3.53		69.53	
0.0		73.09	

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THE SYSTEM COPPER SULFATE - LITHIUM SULFATE - WATER

Data of Crockford and Webster, 1930

Results at 0°			Results at 25°			Results at 55°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Li_2SO_4	CuSO_4		Li_2SO_4	CuSO_4		Li_2SO_4	CuSO_4	
0.0	14.22	Cu	0.0	18.50	Cu	0.0	26.90	Cu
4.90	11.47	"	7.52	14.54	"	3.36	24.45	"
8.57	10.47	"	12.36	12.77	"	6.22	23.08	"
20.00	6.95	"	17.06	10.80	"	12.70	18.75	"
23.78	5.57	" + Li	18.03	10.46	"	17.27	16.53	"
25.21	2.49	Li	21.32	9.18	" + Li	18.36	15.85	" + Li
25.95	1.14	"	24.32	3.64	Li	19.85	12.90	Li
26.33	0.0	"	25.50	0.0	"	22.55	6.07	"
						24.62	0.0	"

Cu = $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$; Li = $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$.

Data of Schreinemakers, 1908, 1909 at 30°

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
Li_2SO_4	CuSO_4		Li_2SO_4	CuSO_4	
0	20.32	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	17.92	11.04	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
3.54	17.59	"	20.55	10.05	" + $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
6.08	16.10	"	22.23	6.41	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
11.94	13.55	"	23.59	3.39	"
15.72	12.14	"	25.24	0	"

THE SYSTEM COPPER SULFATE - MAGNESIUM SULFATE - WATER

Results of Diacon, 1866 at 0°

Gms. per 100 Gms. H_2O		Solid Phase	Gms. per 100 Gms. H_2O		Solid Phase
CuSO_4	MgSO_4		CuSO_4	MgSO_4	
0	26.37	$\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$	12.03	15.67	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
2.64	25.91	"	13.61	8.64	"
4.75	25.30	"	14.99	0	"
9.01	23.30	$\text{MgSO}_4 \cdot 6\text{H}_2\text{O} + \text{CuSO}_4 \cdot 5\text{H}_2\text{O}$			

Results of Inguzzi, 1948 at 30°

Solution wt. %		Solid Phase wt. %		Solution wt. %		Solid Phase wt. %	
CuSO ₄	MgSO ₄	CuSO ₄	MgSO ₄	CuSO ₄	MgSO ₄	CuSO ₄	MgSO ₄
Solid Solution I				Solid Solutions II + III			
1.57	26.63	0.25	48.36	10.07	19.31	23.74	28.18
2.19	25.94	0.70	48.16			56.20	6.80
6.04	23.17	2.81	46.53				
Solid Solutions I + II				Solid Solution III			
6.07	23.07	3.07	45.85	10.28	18.82	58.86	4.46
		17.51	33.41	11.28	16.54	60.47	3.15
Solid Solution II				13.24	12.06	61.31	2.26
				14.76	8.93	61.42	2.26
7.92	21.79	20.31	30.94	16.35	5.84	62.26	1.39
8.28	20.98	21.12	30.42	17.79	3.13	62.64	1.34
8.46	20.06	21.49	29.78	18.13	1.94	62.94	1.10

50

THE SYSTEM COPPER SULFATE - MANGANESE SULFATE - WATER
(Stortenbecker, 1900)

Results at 18°

Mols. per 100 Mols. H ₂ O		Mol. per cent Cu in:		Mols. per 100 Mols. H ₂ O		Mol. per cent Cu in:	
Cu	Mn	Solution	Crystals	Cu	Mn	Solution	Crystals
Solid Phase, CuMnSO ₄ ·5H ₂ O, Triclinic				Solid Phase, CuMnSO ₄ ·5H ₂ O, Triclinic			
2.282	0	100	100	[0.73	6.37	10.27	10.5]
...	...	90.5	...	...	...	5.0	4.9
2.23	0.44	83.5	...	0.34	7.03	4.60	...
...	...	74.1	97.3	...	...	2.31	2.15
...	...	57.7	95.1	...	7.375	0.0	0.0
...	...	31.0	81.3	Solid Phase, CuMnSO ₄ ·Monoclinic·7H ₂ O			
1.54	3.76	29.0	...	...	...	20.4	28.2*
...	...	26.1	70.4	...	...	15.9	23.5]
1.31	4.70	21.8	...	[1.06	5.58	12.45	20.8
...	...	21.2	42.6	...	...	10.27	16.0]
...	...	20.0	34.4	[0.73	6.37	4.60	5.8*
[1.06	5.58	15.9	22.9]	...	...	0.0	0.0
...	...	13.9	15.2*	...	±8		

* Metastable

CuMnSO₄·5H₂O = 100-90.8 and 2.11-0 mol. per cent Cu.CuMnSO₄·7H₂O = 37.8-4.92 mol. per cent Cu.

(Cont.)

Cu CUPRUM

Results at 25°

Gms. per 100 Gms. H ₂ O		Mols. per 100 Mols. H ₂ O		Mol. % Cu in Solution	Mol. % Cu in Crystals
CuSO ₄	MnSO ₄	Cu	Mn		
Triclinic Crystals with 5H ₂ O					
20.2	0	2.282	0	100	100
				90.5	99.3
19.76	3.69	2.23	0.44	83.5	...
				74.1	97.3
				57.7	95.1
				31.0	81.3
13.65	31.52	1.54	3.76	29.0	...
				26.1	70.4
11.61	39.41	1.31	4.70	21.8	...
				21.2	42.6
				20.0	34.4
9.39	46.77	1.06	5.59	15.9	22.9
				13.45*	15.2*
6.47	53.39	0.73	6.37	10.27	10.5
				5.0	4.9
3.01	58.93	0.34	7.03	4.6	...
				2.31	2.15
0.0	61.83	0.0	7.375	0.0	100.0
Monoclinic Crystals with 7H ₂ O					
9.39	46.77	1.06	5.58	20.0	28.2
				15.9	23.5
				13.45	20.8
6.47	53.39	0.73	6.37	10.27	16.0
				4.6*	5.8*
0.0	67.07±	0.0	8± *	0.0	100

* Metestable

For data at 0° and 17° see Holleman, 1905-6.

THE SYSTEM COPPER SULFATE - NICKEL SULFATE - WATER
(Data of Fock, 1897)

Results at 35°

Gms. per 100 Gms. H ₂ O		Mol. per cent in Solution		Mol. per cent in Solid Phase		Crystal Form
CuSO ₄	NiSO ₄	CuSO ₄	NiSO ₄	CuSO ₄	NiSO ₄	
9.62	583.9	1.57	98.43	0.35	99.65	Rhombic
41.66	484.4	7.69	92.31	2.12	97.88	"
75.39	553.5	11.66	88.34	4.77	95.23	Tetragonal
106.40	506.5	16.92	83.08	6.52	93.48	"
172.0	483.8	25.63	74.37	13.88	86.17	"
186.9	468.0	27.90	72.10	18.77	81.23	Tetragonal
				94.91	5.09	Triclinic
Results at 67°						
20.04	729.3	2.65	97.35	0.93	99.07	Monoclinic
66.01	706.2	8.31	91.69	2.86	97.14	"
88.08	501.6	13.55	86.45	3.92	96.08	"
47.94	675.0	16.39	83.61	6.66	93.34	"
249.9	747.8	24.46	75.54	22.32	77.68	{ Monoclinic Triclinic

(Data of Eckstein and Lissner, 1954)

The authors present their data in graphical form. At each temperature the two branches of the solubility curves are nearly linear. The compositions of the invariant solutions are as follows:

t°	Gms. per 100 gms. sat. sol.		Solid Phase	
	CuSO ₄	Na ₂ SO ₄		
15	8.5	20.3	Copper-rich solid solution + nickel-rich solid solution (Cu,Ni)SO ₄ ·5H ₂ O + (Ni,Cu)SO ₄ ·7H ₂ O	SO
30	8.9	23.2		
50	10.3	26.4		
70	13.6	27.5		

THE SYSTEM COPPER SULFATE - SODIUM SULFATE - WATER
(Caven and Johnston, 1927)

Results at 0°, 25° and 27.5°

Note: The author's original figures for the Na₂SO₄ values have been corrected by multiplying by the factor 0.838 as requested in the supplementary note to their paper.

Results at 0°			Results at 25°			Results at 37.5°		
Gm. mols. per 1000 gms. H ₂ O		Solid Phase	Gm. mols. per 1000 gms. H ₂ O		Solid Phase	Gm. mols. per 1000 gms. H ₂ O		Solid Phase
CuSO ₄	Na ₂ SO ₄		CuSO ₄	Na ₂ SO ₄		CuSO ₄	Na ₂ SO ₄	
0.0	0.324	Na ₂ SO ₄	0.0	1.972	Na ₂ SO ₄	0.0	3.406	Na ₂ SO ₄
0.213	0.348	"	0.256	2.005	"	0.162	3.391	" + 1.1.2
0.415	0.377	"	0.593	2.038	"	0.280	2.667	1.1.2
0.590	0.392	"	0.781	2.062	" + 1.1.2	0.678	1.713	"
1.047	0.441	" + Cu ₅	0.847	1.724	1.1.2	0.821	1.509	"
0.998	0.250	Cu ₅	0.979	1.438	"	1.209	1.179	"
0.970	0.147	"	1.068	1.343	"	1.402	1.041	"
0.929	0.0	"	1.457	1.109	Cu ₅	1.770	0.843	" + Cu ₅
			1.433	0.641	"	1.754	0.0	Cu ₅
			1.428	0.0				

Na₂SO₄ = Na₂SO₄·10H₂O; Cu₅ = CuSO₄·5H₂O; 1.1.2 = CuSO₄·Na₂SO₄·2H₂O;
Na = Na₂SO₄.

Results at 20°
(Massink, 1918)

(Data at 20° and 35° are also given by Massink, 1916, 1917)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuSO ₄	Na ₂ SO ₄		CuSO ₄	Na ₂ SO ₄	
0.0	16.25	Na ₂ SO ₄ ·10H ₂ O	15.54	11.85	1.1.2 + CuSO ₄ ·5H ₂ O
5.69	15.99	"	16.51	6.09	CuSO ₄ ·5H ₂ O
11.22	15.45	" + 1.1.2	17.52	0.0	"
13.30	13.78	1.1.2			1.1.2 = CuSO ₄ ·Na ₂ SO ₄ ·2H ₂ O.

Cu CUPRUM

Results at 97°
(Benrath and Benrath, 1929)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	CuSO ₄	Na ₂ SO ₄		CuSO ₄	Na ₂ SO ₄	
	0.0	30.50	Na ₂ SO ₄	18.80	8.75	1.1.2
	1.43	29.91	" + 1.1.2	22.46	7.44	"
	1.95	27.00	1.1.2	20.48	5.90	"
	2.95	22.40	"	34.91	3.42	" + CuSO ₄ ·3H ₂ O
	4.13	19.22	"	36.06	3.26	" + "
50	5.92	16.91	"	36.40	2.46	CuSO ₄ ·3H ₂ O
	9.97	13.57	"	37.52	0.97	"
	12.52	11.92	"	38.30	0.0	

1.1.2 = CuSO₄·Na₂SO₄·2H₂O

Results at Several Temperatures Between 0° and 30°
(Koppel, 1901-02; Massol and Malmes, 1901)

t°	Gms. per 100 gms. Solution		Mols. per 100 Mols. H ₂ O		Solid Phase
	CuSO ₄	Na ₂ SO ₄	CuSO ₄	Na ₂ SO ₄	
0	13.40	6.23	1.88	0.98	CuSO ₄ ·5H ₂ O + Na ₂ SO ₄ ·10H ₂ O
10	14.90	9.46	2.23	1.56	"
15	15.18	11.64	2.34	2.02	"
17.7	14.34	13.34	2.24	2.34	CuSO ₄ ·Na ₂ SO ₄ ·2H ₂ O
23	14.36	12.76	2.23	2.21	"
40.15	13.73	12.26	2.10	2.10	"
17.7	14.90	13.48	2.37	2.39	CuSO ₄ ·Na ₂ SO ₄ ·2H ₂ O + CuSO ₄ ·5H ₂ O
23	16.41	11.35	2.57	1.99	"
40.15	20.56	8.00	3.25	1.47	"
18	13.53	13.84	2.10	2.41	CuSO ₄ ·Na ₂ SO ₄ ·2H ₂ O + Na ₂ SO ₄ ·10H ₂ O
20	11.34	15.70	1.76	2.73	"
25	6.28	21.20	0.98	3.70	"
30	2.607	28.38	0.43	5.21	"
33.9	1.475	32.30	0.25	6.18	"
37.2	1.494	31.96	0.25	6.08	"
30	5.38	22.17	...	...	{ CuSO ₄ ·Na ₂ SO ₄ ·2H ₂ O + increasing amts. of Na ₂ SO ₄ ·10H ₂ O
30.1	3.69	25.37			
30	1.57	32.09			

Data for the system CuSO₄ + Na₂SO₄ + H₂SO₄ + H₂O at 12° and at 25° are given by Foote, 1919.

Data for the system CuSO₄ + 2NaNO₃ ⇌ Cu(NO₃)₂ + Na₂SO₄ (+ H₂O) at 20°, are given by Massink, 1918.

THE SYSTEM COPPER SULFATE - THALLOUS SULFATE - WATER
(Ricci and Fischer, 1952; Benrath, 1926a)

Benrath presents only a diagram of the 30° isotherm in which the double salt is incongruently soluble. Locke (1902) reports the "solubility" of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ to be about 7.5 wt. % which agree with Ricci and Fischer's value for the solution saturated with double salt and Ti_2SO_4 .

Results at 25°
(Ricci and Fischer, 1952)

[additional data are presented in graphical form]

30

Gms. per 100
gms. sat. sol.

Ti_2SO_4	CuSO_4	Density	Solid Phase
5.22	0.0	1.046	Ti_2SO_4
5.65	1.86	1.070	$\text{Ti}_2\text{SO}_4 + \text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$
2.81	18.70	1.237	$\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O} + \text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
0.0	18.50	1.206	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

THE SYSTEM $\text{CuSO}_4 \cdot \text{Ti}_2\text{SO}_4 \cdot 6\text{H}_2\text{O} - \text{CuSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O} - \text{H}_2\text{O}$ AT 25°
(Ricci and Fischer, 1952)

[continuous solid solutions are formed]

Saturated Solution wt. %			Original complex wt. %			Density
Ti_2SO_4	$(\text{NH}_4)_2\text{SO}_4$	CuSO_4	Ti_2SO_4	$(\text{NH}_4)_2\text{SO}_4$	CuSO_4	
4.75	0.87	2.69	7.56	0.90	3.52	1.077
2.89	4.27	6.02	7.58	4.52	7.85	1.116
1.58	6.52	8.28	3.81	7.26	9.98	1.140
0.60	7.81	9.53	1.52	9.07	11.43	1.154
0.16	8.28	9.95	0.38	9.75	11.90	1.155

THE SYSTEM $\text{CuSO}_4 \cdot \text{Ti}_2\text{SO}_4 \cdot 6\text{H}_2\text{O} - \text{CuSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O} - \text{H}_2\text{O}$ AT 25°
(Ricci and Fischer, 1952)

[continuous solid solutions are formed]

Saturated Solution wt. %			Original Complex wt. %			Density
Ti_2SO_4	K_2SO_4	CuSO_4	Ti_2SO_4	K_2SO_4	CuSO_4	
5.15	0.47	2.12	7.57	0.52	2.87	1.073
3.12	2.77	3.55	7.57	3.65	5.74	1.088
2.48	3.42	3.95	7.29	5.64	7.47	1.092
0.98	4.71	4.66	2.29	7.33	7.44	1.095
0.68	4.93	4.76	1.52	7.85	7.67	1.094
0.37	5.14	4.87	0.76	8.36	7.90	1.093

THE SYSTEM $\text{Ti}_2\text{SO}_4 - (\text{NH}_4)_2\text{SO}_4 - \text{CuSO}_4 - \text{H}_2\text{O}$ AT 25°
(Ricci and Fischer, 1952)

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
Ti_2SO_4	$(\text{NH}_4)_2\text{SO}_4$	CuSO_4	Density	Ti_2SO_4	$(\text{NH}_4)_2\text{SO}_4$	CuSO_4	Density
Solid phase $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ + Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $(\text{NH}_4)_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.				Solid phase - Solid Solution of Ti_2SO_4 with $(\text{NH}_4)_2\text{SO}_4$ + Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $(\text{NH}_4)_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.			
2.43	0.86	18.90	1.246	5.76	1.23	1.76	1.076
2.49	0.87	18.86	1.248	5.97	2.76	1.69	1.090
2.34	1.29	18.91	1.251	6.20	4.30	1.63	1.101
1.62	2.73	19.12	1.256	6.26	4.68	1.63	1.104
0.67	4.44	19.34	1.261	6.49	6.55	1.54	1.119
0.32	5.01	19.44	1.256	7.10	13.23	1.32	1.166
0.25	5.02	19.46	1.256	6.20	30.79	0.60	1.256
Solid phase - Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $(\text{NH}_4)_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.				6.18	30.88	0.60	1.255
1.71	3.24	16.78	1.225	6.15	30.92	0.59	1.255
1.07	4.63	16.22	1.223	5.39	34.56	0.49	1.256
1.01	4.11	18.57	1.247	5.31	34.95	0.46	1.267
				3.14	39.53	0.38	1.265
				2.52	40.54	0.38	1.261

THE SYSTEM $\text{Ti}_2\text{SO}_4 - \text{K}_2\text{SO}_4 - \text{CuSO}_4 - \text{H}_2\text{O}$ AT 25°
(Ricci and Fischer, 1952)

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.			
Ti_2SO_4	K_2SO_4	CuSO_4	Density	Ti_2SO_4	K_2SO_4	CuSO_4	Density
Solid phase - $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ + Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $\text{K}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.				Solid phase - Solid Solution of Ti_2SO_4 with K_2SO_4 + Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $\text{K}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.			
2.62	0.42	18.77	1.244	5.58	0.38	1.91	1.073
2.13	1.07	18.90	1.249	5.04	3.51	1.42	1.093
1.56	1.70	19.02	1.251	4.93	7.27	1.04	1.119
0.56	2.53	19.17	1.249	4.57	9.41	0.927	1.131
0.25	2.67	19.22	1.245	4.50	9.56	0.912	1.134
0.23	2.72	19.23	1.247	4.31	9.68	0.911	1.133
Solid phase - Solid Solution of $\text{Ti}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$ with $\text{K}_2\text{SO}_4 \cdot \text{CuSO}_4 \cdot 6\text{H}_2\text{O}$				4.23	9.71	0.926	1.132
0.51	3.11	15.57	1.204	4.21	9.69	0.933	1.132
0.17	3.31	15.90	1.207	3.29	9.99	1.005	1.125
				2.51	10.26	1.078	1.119

THE SYSTEM COPPER SULFATE - ZINC SULFATE - WATER
(Stortenbecker, 1897)

Results at 18°

Mols. per 100
Mols. H₂O

Cu	Zn	Mol. % Cu in Solution	Mol. % Cu in Crystals	Solid Solutions:	
2.28	0	100	100	Triclinic Crystals with H ₂ O	30
1.83	2.08	46.8	94.9		
1.41	3.60	28.1			
1.19	5.01	19.2	77.9		
1.86	3.36	36.2	40.4	Monoclinic Crystals with 7H ₂ O	
1.22	4.45	21.5	29.5-31.9		
1.01	4.72	17.6	24.1-28.		
0.82	5.03	14.0	19.0-22.		
0.51	5.59	8.36	12.4-14.9	Rhombic Crystals with 7H ₂ O	
0.30	5.56	4.87	7.02		
0.0	6.42	0.0	0.0		
1.19	5.01	19.2	5.01		
0.51	5.59	8.36	1.97		
0.267	5.77	4.42	1.15		
0.0	5.94	0.0	0.00		

A few results for the system CuSO₄ + ZnSO₄ + H₂O at 12°, 18°, 25°, 35°, 40°, and 45° are given by Hollesan, 1905-06.

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF VARIOUS
CHLORIDES AT 25°
(Herz, 1910)

In Lithium Chloride		In Potassium Chloride		In Rubidium Chloride		In Sodium Chloride	
Gms. per 100 cc Sat. Sol.		Gms. per 100 cc Sat. Sol.		Gms. per 100 cc Sat. Sol.		Gms. per 100 cc sat. sol.	
LiCl	CuSO ₄	KCl	CuSO ₄	RbCl	CuSO ₄	NaCl	CuSO ₄
3.10	20.06	4.19	23.89	0	22.34	2.10	22.41
5.93	18.78	8.75	24.92	13.22	25.02	7.72	22.76
12	17.03	17.50	29.03			14.79	24.05

Cu CUPRUM

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF ETHYLENE GLYCOL ($\text{CH}_2\text{OHCH}_2\text{OH}$) AT 30° (Trimble, 1931)

d of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	$\text{CH}_2\text{OHCH}_2\text{OH}$	CuSO_4	
1.2259	0.0	27.65	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
1.1941	7.34	25.46	"
1.1502	22.26	18.02	"
1.1363	28.50	14.84	"
1.1202	50.25	9.26	"
1.1406	66.66	9.16	"
1.2535	71.61	23.62	"
1.3267	67.71	32.21	"

At 14°, 100 gms. of a solution saturated with $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ contain 7.6 gms. CuSO_4 .

100 gms. sat. sol. of anhydrous CuSO_4 in pure glycol contain 0.5 gm. CuSO_4 at 30°.

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF URETHAN ($\text{NH}_2\text{COOC}_2\text{H}_5$) AT 25° (Palitzsch, 1928, 1929)

Gm. mols. per 1000 gms. H_2O		Solid Phase
$\text{NH}_2\text{COOC}_2\text{H}_5$	CuSO_4	
0.0	1.42	$\text{CuSO}_4 \cdot ?\text{H}_2\text{O}$
1.24	0.85	"
9.119	0.122	"

A phase diagram for the system CuSO_4 - Sucrose - Water at 30° is drawn by Kelly, 1954. No compounds are formed. A solution saturated with $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ + Sucrose contains 59.6% Sucrose, 1.5% CuSO_4 .

SOLUBILITY OF COPPER SULFATE IN ABSOLUTE METHYL ALCOHOL (Gibson, Driscoll and Jones, 1929)

When copper sulfate is added to a large excess of methyl alcohol the amount of salt dissolved at first increases and then decreases as the sparingly soluble basic salt, $\text{CuO} \cdot 4\text{CuSO}_4 \cdot 6\text{CH}_3\text{OH}$, is formed. The mono-alcoholate is prepared by wetting anhydrous copper sulfate with absolute methyl alcohol and allowing to stand at 15°.

t°	Gms. CuSO_4 per 100 gms. sat. sol.	Solid Phase
15	0.76	$\text{CuSO}_4 \cdot \text{CH}_3\text{OH}$
25	1.40	"
35	2.15	"
45	2.90	"

SOLUBILITY IN OTHER METHANOL SOLUTIONS
(de Bruyn, 1892; de Coninck, 1905)

Solvent	t°	Gms. per 100 Gms. Solvent	
		CuSO ₄	CuSO ₄ ·5H ₂ O
Methyl Alcohol Abs.	3	...	13.4
" " Abs.	18	1.05	15.6
" " 93.5%	18	...	0.93
" " 50%	18	...	0.40

Other data for the solubility of copper sulfate in methyl alcohol are given by Carrara and Minozzi, 1897.

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SOLUBILITY OF COPPER SULFATE IN OTHER SOLVENTS

Solvent	t°		Solubility	Author
Ethyl alcohol 10 wt. %	15	15.3	gms. CuSO ₄ ·5H ₂ O per 100 gms. Solvent	(Schiff, 1861)
" " 20 wt. %	15	3.2	" "	(" ")
" " 40 wt. %	15	0.25	" "	(" ")
" " 50%	Room	0.080	gms. CuSO ₄ per 100 gms. sat. sol.	(Grinberg and Zemlyakova, 1948)
50% ethyl alcohol saturated with benzene	Room	0.0091	" " "	(" ")
Ethyl alcohol 100%	3	1.1	gms. CuSO ₄ ·5H ₂ O per 100 gms. solvent	(de Bruyn, 1892; de Coninck, 1905)
Glycerol	15.5	30	" "	(" ; ")
"	15-16	36.3	" "	(Ossendowski, 1907)
95% Formic Acid	18.5	0.05	" "	(Aschan, 1913)
Anhy. Hydrazine	Room	2	gms. CuSO ₄ per 100 gms. sat. sol. (with decomposition)	(Welsh and Broder-son, 1915)

Melting point data are given for:

CuSO ₄ + Na ₂ SO ₄	Plyushehev, Zhdanov, Komissarova and Uvad'eva, 1953; Bellanca and Carapezza, 1951a
CuSO ₄ + K ₂ SO ₄	Bellanca and Carapezza, 1951a
CuSO ₄ + Na ₂ SO ₄ + K ₂ SO ₄	Bellanca and Carapezza, 1951, 1951a

COPPER DITHIONATE CuS₂O₆

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SOLUBILITY IN WATER
(de Baat, 1926)

t°	Gms. CuS ₂ O ₆ per 100 gms. sat. sol.
0	43.82
20	44.91
30	45.51

Cu CUPRUM

THE SYSTEM COPPER DITHIONATE - AMMONIUM DITHIONATE - WATER AT 30°
(de Baat, 1926)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuS_2O_6	$(\text{NH}_4)_2\text{S}_2\text{O}_6$		CuS_2O_6	$(\text{NH}_4)_2\text{S}_2\text{O}_6$	
10.45	52.62	$(\text{NH}_4)_2\text{S}_2\text{O}_6 \cdot \frac{1}{2}\text{H}_2\text{O}$	36.19	18.39	$\text{D}_8 + \text{CuS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$
24.17	38.30	" + D_8	37.26	16.16	$\text{CuS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$
29.70	29.28	D_8	41.06	8.91	"
36.04	18.50	"	45.51	0.00	"

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D_8 = Double salt, the composition of which is not stated.

COPPER SULFANATE $\text{Cu}(\text{SO}_3\text{NH}_2)_2$

74.73 gms. copper sulfanate dissolve in 100 gms. H_2O at 25°.
(Baker, 1949)

COPPER SELENIDE Cu_2Se , CuSe

COPPER SELENITE CuSeO_3

SOLUBILITY OF EACH SEPARATELY IN SEVERAL SOLVENTS AT ROOM TEMPERATURES
(Geilmann and Wrigge, 1931)

The determinations were made for the purpose of separating copper selenides from copper selenite by means of solubility differences. Two grams of each compound were digested in 250 cc of each solvent, with active shaking by hand, and the dissolved Cu and Se determined after 24 hours.

The authors also give experiments showing the comparative action of ammonia and acids upon the selenides, during a shorter period of time, in the absence of and in the presence of air and hydrogen peroxide.

Milligrams Cu and Se dissolved per 250 cc in:

Compound	Conc. of Solvent, Normality	Ammonia		HCl		H_2SO_4		CH_3COOH	
		Cu	Se	Cu	Se	Cu	Se	Cu	Se
$\text{CuSeO}_3 \cdot 2\text{H}_2\text{O}$	0.0	1.6	2.0	1.6	2.0	1.0	2.0	1.6	2.0
"	0.01	2.2	13.8	38.9	48.9	55.8	68.7	3.2	3.9
"	0.02	6.6	26.1	92.6	115.0	109.0	134.7	13.4	16.6
"	0.05	45.5	116.5	232.2	288.0	244.8	301.4	19.0	28.8
"	0.10	181.1	285.1	560.6	678.4	560.6	698.4	25.1	31.3
"	0.20	500.6	698.4	560.6	698.4	560.6	698.4	32.1	40.0
"	2.00	560.6	698.4	560.6	698.4	560.6	698.4	85.7	106.5
Cu_2Se	0.00	trace	-	trace	-	trace	-	trace	-
"	0.01	trace	-	4.2	-	4.8	-	8.5	-
"	0.02	trace	-	5.1	-	5.0	-	12.6	-
"	0.05	2.8	trace	7.4	-	9.4	-	12.8	-
"	0.10	9.1	0.4	9.0	-	9.5	-	14.1	-
"	0.20	19.5	0.6	11.0	-	9.5	-	14.3	-
"	0.50	26.2	0.7	16.2	-	10.0	-	14.6	-
"	1.00	43.0	0.9	25.4	-	10.2	-	14.6	-
"	2.0	54.5	0.8	25.1	-	10.5	-	14.9	-
CuSe	0.02	trace	trace	trace	-	trace	-	-	-
"	0.10	trace	-	slight	-	slight	-	trace	-
"	0.20	1.8	slight	2.5	-	2.2	-	2.0	-
"	0.50	3.1	1.1	5.0	-	2.6	-	2.5	-
"	1.00	3.4	1.9	5.2	-	3.2	-	2.8	-
"	2.00	3.6	2.8	5.8	-	3.1	-	2.8	-

COPPER SELENATE CuSeO_4

SeO

SOLUBILITY IN WATER

t°	Gms. CuSeO_4 per 100 gms. sat. sol.		Density (Klein, K. & C.)	Solid Phase
	Klein, 1940	Kao and Chang, 1940		
-0.5	6.13	-	1.0646	Ice
-1.0	-	-	-	Ice + $\text{CuSeO}_4 \cdot 5\text{H}_2\text{O}$
0	10.44	10.75	1.1206	$\text{CuSeO}_4 \cdot 5\text{H}_2\text{O}$
5	-	11.68	-	"
10	-	12.69	-	"
15	-	13.76	1.1502 (K. & C.)	"
17.5	-	14.32	1.1562 (K. & C.)	"
20	-	14.90	1.1624 (K. & C.)	"
21.2	14.73	-	1.1654	"
25	[16.09 ^a , 15.89 ^b]	16.11	1.1754 (K. & C.)	"
30	-	17.38	-	"
35	-	18.73	-	"
40	19.72*	20.14	1.2235	"
54	24.27	-	1.2827	"
60.2	26.74	-	1.3128	"
70	30.40	-	1.3660	"
80	34.93	-	1.4318	"

*at 40.2°

^aKing and Beckman, 1945^bMacalpine and Sayce, 1932SOLUBILITY OF COPPER SELENATE IN SELENIC ACID SOLUTIONS AT 25°
(Macalpine and Sayce, 1932)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
CuSeO_4	H_2SeO_4		CuSeO_4	H_2SeO_4	
15.89	0.0	$\text{CuSeO}_4 \cdot 5\text{H}_2\text{O}$	2.82	42.55	$\text{CuSeO}_4 \cdot 5\text{H}_2\text{O}$
13.44	6.16	"	1.98	50.16	"
11.84	11.11	"	1.91	53.46	"
10.09	15.27	"	2.01	54.03	"
7.96	20.25	"	0.97	61.05	$\text{CuSeO}_4 \cdot 3\text{H}_2\text{O}$
6.79	25.06	"	0.89	62.82	"
5.49	28.28	"	0.70	66.00	"
3.94	35.39	"	trace	70.36	"
3.15	38.96	"	0.0	82.42	"

DI DIDYMIUM

SeO

EQUILIBRIUM IN THE SYSTEM $\text{Cu}(\text{OH})_2 - \text{CuSeO}_4 - \text{H}_2\text{O}$ AT 30°
(Baroni, 1942)

Saturated Solution			Saturated Solution		
Moles CuO per mole SeO ₃	Moles H ₂ O per mole SeO ₃	Solid Phase	Moles CuO per mole SeO ₃	Moles H ₂ O per mole SeO ₃	Solid Phase
0.950	50.0	$4\text{CuO} \cdot \text{SeO}_3 \cdot \text{H}_2\text{O}$	.970	300.0	$4\text{CuO} \cdot \text{SeO}_3 \cdot \text{H}_2\text{O}$
.952	90.0	"	.975	315.0	"
.971	175.0	"	.960	500.0	"
.960	240.0	"	.950	700.0	"

THE SYSTEM COPPER SELENATE - AMMONIUM SELENATE - WATER AT 25°
(King and Beckman, 1945)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$(\text{NH}_4)_2\text{SeO}_4$	CuSeO_4		$(\text{NH}_4)_2\text{SeO}_4$	CuSeO_4	
0.0	16.09	$\text{CuSeO}_4 \cdot 5\text{H}_2\text{O}$	21.40	3.31	1:1:6
4.89	15.91	"	21.60	3.17	"
6.88	15.98	"	25.47	2.20	"
9.42	16.06	$\text{CuSeO}_4 + 1:1:6$	35.25	0.49	"
9.82	15.61	1:1:6	40.29	.23	"
*10.96	12.30	"	42.71	.19	"
14.67	7.02	"	50.20	Trace	"
18.66	4.47	"	53.84	"	1:1:6 + $(\text{NH}_4)_2\text{SeO}_4$
18.70	4.47	"	54.02	0.0	$(\text{NH}_4)_2\text{SeO}_4$

1:1:6 = $\text{CuSeO}_4 \cdot (\text{NH}_4)_2\text{SeO}_4 \cdot 6\text{H}_2\text{O}$

*The solubility of Copper Ammonium Selenate (1:1:6) is 23.26 gms.
 $\text{CuSeO}_4 \cdot (\text{NH}_4)_2\text{SeO}_4$ per 100 gms. saturated solution.

VO COPPER VANADATE $\text{Cu}(\text{VO}_3)_2$

Zolotavin (1947) found the Ksp to be 10^{-11} at 18° .

DIDYMIUM COMPOUNDS

(Mixtures of NEODYMIUM and PRAESEODYMIUM Compounds)

DIDYMIUM Ammonium NITRATE $\text{Di}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$

100 gms. H_2O dissolve 292 gms. of the salt at 15° . (Holmberg, 1907)

DIDYMIUM SULFATE $\text{Di}_2(\text{SO}_4)_3$

SO

SOLUBILITY IN WATER
(Marignac, 1853)

t°	Gms. $\text{Di}_2(\text{SO}_4)_3$ per 100 Gms. H_2O	Solid Phase	t°	Gms. $\text{Di}_2(\text{SO}_4)_3$ per 100 Gms. H_2O	Solid Phase
12	43.1	$\text{Di}_2(\text{SO}_4)_3$	?	34.0	$\text{Di}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$
18	25.8	"	19	11.7	$\text{Di}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$
25	20.6	"	40	8.8	"
38	13	"	50	6.5	"
50	11	"	100	1.8	"

DIDYMIUM POTASSIUM SULFATE $\text{K}_2\text{SO}_4 \cdot \text{Di}_2(\text{SO}_4)_3 \cdot 2\text{H}_2\text{O}$ 100 gms. H_2O dissolve 1.6 grams of the double salt at 18°. (Marignac)

DIDYMIUM SULFONATES

SO

SOLUBILITY IN WATER
(Holmberg, 1907)

Salt	Formula	t°	Gms. Anhydrous Salt per 100 Gms. H_2O
Didymium Benzene Sulfonate	$\text{Di}(\text{C}_6\text{H}_5\text{SO}_3)_3 \cdot 9\text{H}_2\text{O}$	15	53.1
" $\overline{\text{m}}$ Nitro Benzene Sulfonate	$\text{Di}(\text{C}_6\text{H}_4(\text{NO}_2)\text{SO}_3)_3 \cdot 6\text{H}_2\text{O}$	15	47.8
" $\overline{\text{m}}$ Chloro " "	$\text{Di}(\text{C}_6\text{H}_4\text{ClSO}_3)_3 \cdot 9\text{H}_2\text{O}$	15	12.7
" $\overline{\text{m}}$ Bromo " "	$\text{Di}(\text{C}_6\text{H}_4\text{BrSO}_3)_3 \cdot 9\text{H}_2\text{O}$	15	14.3
" Chloro Nitro " "	$\text{Di}(\text{C}_6\text{H}_4\text{Cl}(\text{NO}_2)\text{SO}_3)_3 \cdot 16\text{H}_2\text{O}$	15	25.3
" α Naphthalene Sulfonate	$\text{Di}(\text{C}_{10}\text{H}_7\text{SO}_3)_3 \cdot 6\text{H}_2\text{O}$	15	6.1
" 1.5 Nitro " "	$\text{Di}(\text{C}_{10}\text{H}_6(\text{NO}_2)\text{SO}_3)_3 \cdot 6\text{H}_2\text{O}$	15	0.52
" 2.6 " "	$\text{Di}(\text{C}_{10}\text{H}_6(\text{NO}_2)\text{SO}_3)_3 \cdot 9\text{H}_2\text{O}$	15	0.18
" 1.7 " "	$\text{Di}(\text{C}_{10}\text{H}_6(\text{NO}_2)\text{SO}_3)_3 \cdot 9\text{H}_2\text{O}$	15	1.3

*($\text{SO}_3:\text{NO}_2:\text{Cl} = 1.3.6$).

Dy DYSPROSIUM

CO DYSPROSIUM OXALATE $Dy_2(C_2O_4)_3$

SOLUBILITY OF DYSPROSIUM OXALATE IN AQUEOUS SOLUTIONS OF
NITRIC ACID ALONE AND CONTAINING OXALIC ACID AT 90°
(Neckers and Kramers, 1928)

Solvent	t°	Gms. Dy_2O_3 per 100 cc sat. sol.	Solid Phase
Aq. 2.5 normal HNO_3	90	1.8458	$Dy_2(C_2O_4)_3 \cdot 10H_2O$
" " " " + 5% $(COOH)_2$	90	0.4215	"
" 5.0 " " " + 5% $(COOH)_2$	90	4.8470	"
" " " " + 5% $(COOH)_2$	90	3.4135	"

SOLUBILITY OF DYSPROSIUM OXALATE IN ORGANIC SOLVENTS

100 cc aq. 20% methylamine oxalate dissolve	0.276 gm. $Dy_2(C_2O_4)_3$	} (Grant & James, 1917)
" " " ethylamine " "	1.787 " "	
" " " triethylamine " "	1.432 " "	

CH DYSPROSIUM SODIUM ETHYLENEDIAMINE TETRA ACETATE $DyNaC_2H_4N_2(COO)_4 \cdot nH_2O$ DYSPROSIUM POTASSIUM ENTYLENEDIAMINE TETRA ACETATE $DyKC_2H_4N_2(COO)_4 \cdot H_2O$

SOLUBILITY OF EACH SEPARATELY IN WATER
(Marsh, 1955)

t°	Gms. "hydrated" sodium salt per liter sat. sol.	Gms. "hydrated" potassium salt per liter sat. sol.
2	46	86
25	133	273
35	199	403

NO DYSPROSIUM NITRATE

Data for the distribution of dysprosium between aq. HNO_3 and
n-tributyl phosphate are given by Weaver, Kappelmann and Topp, 1953.

PO DYSPROSIUM Dimethyl PHOSPHATE $Dy[(CH_3)_2PO_4]_3$

SOLUBILITY OF DYSPROSIUM DIMETHYL PHOSPHATE IN WATER
(Marsh, 1939)

t°	Gms. $Dy[(CH_3)_2PO_4]_3$ per 100 gms. H_2O	Gms. Dy_2O_3 per liter sat. sol.
0	15.0	52
25	8.24	28.5
50	4.83	16.7

DYSPROSIUM SULFATE $Dy_2(SO_4)_3 \cdot 8H_2O$

100 gms. H_2O dissolve 5.072 gms. $Dy_2(SO_4)_3 \cdot 8H_2O$ at 20° and 3.34 gms. at 40° . Jackson and Rienacker, 1930.

ERBIUM OXALATE $Er_2(C_2O_4)_3$

CO

SOLUBILITY IN AQ. SULFURIC ACID AT 25°
(Wirth, 1912)

Normality of Aq. H_2SO_4	Gms. per 100 gms. sat. sol.		Solid Phase
	Er_2O_3	$Er_2(C_2O_4)_3$	
2.16	0.329	0.5144	$Er_2(C_2O_4)_3 \cdot 14H_2O$
3.11	0.493	0.7708	"
4.32	0.7036	1.10	"
6.175	1.10	1.72	"

ERBIUM SODIUM ETHYLENEDIAMINETETRA ACETATE $ErNa C_2H_4N_2(COO)_4 \cdot nH_2O$

CH

ERBIUM POTASSIUM ETHYLENEDIAMINETETRA ACETATE $ErK C_2H_4N_2(COO)_4 \cdot mH_2O$

SOLUBILITY OF EACH SEPARATELY IN WATER
(Marsh, 1955)

t°	Gms. "hydrated" salt per liter saturated solution	
	(Sodium Salt)	(Potassium Salt)
2	196	207
25	450	435
35	589	550

ERBIUM NITRATE $Er(NO_3)_3$

NO

100 ml. of a saturated solution of erbium nitrate in ether at 20° contain 190 mg. Er_2O_3 . (Wells, 1930)

100 cc of a sat. solution of $Er(NO_3)_3 \cdot 6H_2O$ in Et₂O prepared by frequent agitation and allowing to stand overnight at about 20° , contain 1.62 gms. Er_2O_3 . A saturated solution prepared in the same way with erbium nitrate dehydrated at 150° contains 1.90 gms. Er_2O_3 per 100 cc.

Data for the distribution between aq. HNO_3 and n-tributyl phosphate are given by Weaver, Kappelmann and Topp, 1953.

Er ERBIUM

O ERBIUM OXIDE Er_2O_3

OH ERBIUM HYDROXIDE $\text{Er}(\text{OH})_3$

SOLUBILITY IN WATER

25°	8×10^{-7} moles $\text{Er}(\text{OH})_3$ per liter	(Moeller and Kremers, 1944; Moeller and Fogel, 1951)
29°	1.28×10^{-5} moles Er_2O_3 per liter	(Busch, 1927)

Data for the precipitation of Er_2O_3 from ammonium acetate solutions is given by Perey, 1949.

PO ERBIUM Dimethyl PHOSPHATE $\text{Er}_2[(\text{CH}_3)_2\text{PO}_4]_6$

100 gms. H_2O dissolve 1.78 gm. $\text{Er}_2[(\text{CH}_3)_2\text{PO}_4]_6$ at 25°. (Morgan and James, 1914)

SOLUBILITY OF ERBIUM DIMETHYL PHOSPHATE IN WATER
(Marsh, 1939)

These values were obtained by extrapolation from experimental determinations made with a sample containing 85% Er and 15% Yt. The saturated solutions were prepared by stirring the mixture for 3-4 hours at 0°. A portion of this solution was then diluted somewhat and stirred occasionally for 3-4 hours at 25° and at 50°.

t°	Gms. $\text{Er}[(\text{CH}_3)_2\text{PO}_4]_3$ per 100 gms. H_2O	Gms. Er_2O_3 per liter sat. sol.
0	6.91	24.4
25	(1.78)*	11.9
50	2.03	7.2

*Morgan and James, 1914

SO ERBIUM SULFATE $\text{Er}_2(\text{SO}_4)_3$

SOLUBILITY IN WATER

t°	Gms. $\text{Er}_2(\text{SO}_4)_3$ per 100 gms. H_2O	Solid Phase	Author
20	13.0	$\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$	(Jackson and Reinacker, 1930)
25	13.56	"	(Wirth, 1912)
	15.19	"	(Spedding and Jaffe, 1954)
40	5.31	"	(Jackson and Reinacker, 1930)

SOLUBILITY OF ERBIUM SULFATE IN SULFURIC ACID SOLUTIONS AT 25°
(Wirth, 1912)

Normality of H ₂ SO ₄	Gms. per 100 gms. sat. sol.		Solid Phase
	Er ₂ O ₃	Er ₂ (SO ₄) ₃	
Water alone	7.339	11.94	Er ₂ (SO ₄) ₃ ·8H ₂ O
0.1	7.389	12.02	"
0.505	6.249	10.164	"
1.1	5.256	8.549	"
2.10	3.98	6.473	"
6.175	0.9352	1.521	"
12.6	0.0852	0.1386	"

ERBIUM Bromonitrobenzene SULFONATE Er(1,4,2-C₆H₃Br·NO₂·SO₃)₃·12H₂O

100 gms. sat. solution in water contain 6.056 gms. anhydrous salt
at 25°. (Katz and James, 1913)

EUROPIUM HYDROXIDE Eu(OH)₃

The solubility in water at 25° is 1.4 x 10⁻⁶ moles per liter (Moeller
and Kremers, 1944); 8 x 10⁻⁷ moles per liter (Moeller and Fogel, 1951).

EUROPIUM SULFATE Eu₂(SO₄)₃·8H₂O

100 gms. H₂O sat. with Europium Sulfate dissolve 2.563 gms.
Eu₂(SO₄)₃·8H₂O at 20° and 2.19 gms. at 40°. (Jackson and Rienacker, 1930)

FLUORINE F₂

SOLUBILITY OF FLUORINE IN SEVERAL SOLVENTS
(Burford, Weber, Anderson, Rogers, etal, 1951)

Solvent	Temp °C	Pressure F ₂ P.S.I. Absolute	Solubility ml. F ₂ (S.T.P.) per gm. liquid
Perfluoro oil	50	51	0.13
KF·HF melt (45% HF)	100	65	0.4
" (" ")	100	270	2.3
" (75% HF)	41	303	0.9
" (" ")	400	55	0.2
H ₃ PO ₄	18	60	70.2
SbF ₅	39	61	0.3
	39	373	1.4

Fe FERRUM

IRON Fe

SOLUBILITY OF METALLIC IRON IN MERCURY
(Marshall, Epstein and Norton, 1950)

The iron was reduced with hydrogen and degassed. The mercury wet it completely. Irvin and Russell, 1932 found "less than $1 \times 10^{-5}\%$ at 20° .

t°	Author's Values (Parts per million)		t°	Author's Values (Parts per million)	
	Experimental	Smoothed		Experimental	Smoothed
25	0.013-.017	0.015	400	-	0.11
100	-	.019	500	0.105-.270	.21
200	-	.030	600	-	.45
250	0.037-.066	-	700	1.0 -1.2	.96
300	-	.054			

SOLUBILITY IN MILK

Experiments upon the solubility of iron in milk made by immersing highly polished 4×7.5 cm. strips of steel (18% chromium steel) in raw milk and rocking 46 times per minute for 36 minutes, showed an amount dissolved, as determined by difference in weight of the metal strip, so slight as to be well within the limits of error of the method. (Ouamm, 1929)

Data are given for the following systems:

Fe + P	(Vogel and Horstmann, 1952)
Fe + P + Al	(Vogel and Klose, 1952)
Fe + P + Mn	(Vogel and Berak, 1952)
Fe + N	(Kontorovich and Sovalova, 1949)
Fe + FeS	(Chizhikov, Gulyanitskaya and Bogovarova, 1955)(Vogel and Hillner, 1953)(Olshanskii, 1950)
Fe + FeS + FeO	(Olshanskii, 1950, 1951)
Fe + FeS + FeO + SiO ₂	(Olshanskii, 1950, 1951a)
Fe + NiO \rightleftharpoons FeO + Ni	(Jander and Serf, 1933)
Fe + MnO \rightleftharpoons FeO + Mn	(Krings and Schackmann, 1931)(Herasymanko, 1938)
Fe + PbS \rightleftharpoons FeS + Pb	(Urazov, Borobev, and Ainbinder, 1936)
Fe + NiSiO ₃ \rightleftharpoons FeSiO ₃ + Ni	(Strassen, 1931)
2Fe + SiO ₂ \rightleftharpoons 2FeO + Si	(Herasymanko, 1938)
3Fe + Sb ₂ S ₃ \rightleftharpoons 2Sb + 3FeS	(Lange and Schlegel, 1950)

FERRIC ARSENATES $x\text{Fe}_2\text{O}_3 \cdot y\text{As}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

AsO

THE SYSTEM FERRIC OXIDE - ARSENIC OXIDE - WATER AT 30°
(Takahashi and Sasaki, 1950a)

The tie-line extrapolations were good. This work indicates that the data of Hartshorne, 1927 (below) is probably non-equilibrium.

Gms. per 100 gms. sat. sol.

Fe_2O_3 As_2O_5		Solid Phase
Trace	< 2.48	$\text{Fe}_2\text{O}_3 \cdot \text{As}_2\text{O}_5 \cdot 9\text{H}_2\text{O}$
"	2.48	" + $2\text{Fe}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 22\text{H}_2\text{O}$
0.12	12.00	$2\text{Fe}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 22\text{H}_2\text{O} + \text{Fe}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 17\text{H}_2\text{O}$
	>12.00	$\text{Fe}_2\text{O}_3 \cdot 3\text{As}_2\text{O}_5 \cdot 17\text{H}_2\text{O}$

THE SYSTEM FERRIC OXIDE - ARSENIC OXIDE - WATER AT 25°
(Hartshorne, 1927)

The mixture used for the equilibrium studies was prepared by adding hydrochloric acid to arsenic acid and ferric hydroxide and repeatedly evaporating to dryness to remove the hydrochloric acid. The concentrated mixture had a greenish tint. Portions of it were suitably diluted with water and stirred in the solubility apparatus until attainment of equilibrium. Samples were removed for analysis and either water or syrupy arsenic acid solution added to the residue for obtaining the next equilibrium mixture. Since equilibrium was attained very slowly it is possible that it was not reached in all cases. These data do not agree with those of Takahashi and Sasaki, 1950, above.

Gms. per 100 gms. sat. sol.		Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Fe_2O_3	As_2O_5		Fe_2O_3	As_2O_5	
trace	2.6	1:1:x	0.037	18.82	1:1:x + 1:2:8
"	3.5	"	0.059	21.77	"
"	4.4	"	0.076	23.13	"
"	5.4	"	0.1	8.0	1:2:8
"	5.8	"	"	8.4	"
"	6.4	"	"	12.3	"
0.001	7.96	"	"	13.2	"
0.004	10.11	"	"	14.3	"
0.010	12.49	"	"	14.9	"
0.036	16.19	"	"	15.5	"

1:1:x = $\text{Fe}_2\text{O}_3 \cdot \text{As}_2\text{O}_5 \cdot x\text{H}_2\text{O}$ - where x is not far removed from 6 - There is also present varying amounts of absorbed arsenic acid - Amorphous.
1:2:8 = $\text{Fe}_2\text{O}_3 \cdot 2\text{As}_2\text{O}_5 \cdot 8\text{H}_2\text{O}$, crystalline needles.

(Cont.)

Fe FERRUM

THE SYSTEM FERRIC OXIDE - ARSENIC OXIDE - WATER AT 25°--Contd. Data of Viehherz and Krachevskaja, 1936

Scorodite ($\text{FeAsO}_4 \cdot 2\frac{1}{2}\text{H}_2\text{O}$) was found to decompose completely in NaOH solutions when the molar ratio of As_2O_5 :NaOH equalled 1:6. Solutions in which the As_2O_5 :NaOH ratio exceeded 1:4 contained practically pure Na_3AsO_4 , and there was no iron nor Na_2HASO_4 in the solution.

Br FERROUS BROMIDE FeBr_2

SOLUBILITY OF FERROUS BROMIDE IN WATER (Schimmel, 1929)

The determinations were made in an atmosphere of carbon dioxide.

t°	Gms. per 100 gms. sat. sol.	Solid Phase	t°	Gms. per 100 gms. sat. sol.	Solid Phase
- 6.1	18.5	Ice	- 1.8	50.3	$\text{FeBr}_2 \cdot 6\text{H}_2\text{O}$
-10.7	22.8	"	+12.0	52.2	"
-25.0	35.2	"	21.0	53.9	"
-36.5	40.0	"	30.0	55.4	"
-40.0	41.0	"	41.8	57.2	"
-47.0	43.4*	"	46.5	58.0	"
-60	46.5*	"	49.0	58.45	" + $\text{FeBr}_2 \cdot 4\text{H}_2\text{O}$
-43.6	42.25	" + $\text{FeBr}_2 \cdot 9\text{H}_2\text{O}$	49.5	58.5	$\text{FeBr}_2 \cdot 4\text{H}_2\text{O}$
-39	43.1	$\text{FeBr}_2 \cdot 9\text{H}_2\text{O}$	52.0	58.6	"
-37	43.5	"	57.0	58.8	"
-34.6	44.1	"	65.0	59.5	"
-30.7	46.25	"	75.0	61.5	"
-29.3	47.65	" + $\text{FeBr}_2 \cdot 6\text{H}_2\text{O}$	83.0	63.3	" + $\text{FeBr}_2 \cdot 2\text{H}_2\text{O}$
-28.0	47.7	$\text{FeBr}_2 \cdot 6\text{H}_2\text{O}$	88.0	63.6	$\text{FeBr}_2 \cdot 2\text{H}_2\text{O}$
-22.0	48.0	"	100.0	64.8	"
-12.8	48.7	"	116.0	66.6	"
- 9.0	49.4	"	124.	68.5	"
- 7.0	49.6	"	132 (b.pt.)	70.2	"

THE SYSTEM FERROUS BROMIDE - AMMONIUM BROMIDE - WATER AT 25° (Mercier, 1937)

The determinations were made in an atmosphere of nitrogen. Numerical results are given only for the two triple points. The following approximate values were estimated from the author's diagram.

Gms. per 100 Gms. sat. sol.		Solid Phase	Gms. per 100 Gms. sat. sol.		Solid Phase
FeBr_2	NH_4Br		FeBr_2	NH_4Br	
56.0	0.0	$\text{FeBr}_2 \cdot 4\text{H}_2\text{O}$	30	16.0	NH_4Br
55.1	2.4	" 1.1.6	20	25.0	"
50.0	6.0	1.1.6	100	34.0	"
47.8	9.0	" NH_2Br	0	43.5	"
40.0	10.0	NH_4Br			

1.1.6 = $\text{FeBr}_2 \cdot \text{NH}_4\text{Br} \cdot 6\text{H}_2\text{O}$

100 cc Pyridine dissolve 0.49 gm. FeBr_2 at 25°. (R. Muller, 1924)

FERRIC THIOCYANATE $\text{Fe}(\text{SCN})_3 \cdot 3\text{N}_2\text{O}$

SCN

DISTRIBUTION BETWEEN WATER AND ETHER
(Hantzsch and Vagt, 1901)

Results for the effect of HNO_3 upon the distribution at 25° are also given.

Additional results for this system are also given by Wosnessensky, 1923; and Nesterow and Petine, 1931.

Results at 25°

Results at Several Temperatures

Gm. Mols. $\text{Fe}(\text{SCN})_3$ per Liter				Gm. Mols. $\text{Fe}(\text{SCN})_3$ per Liter		
H_2O Layer (c)	Ether Layer (c')	$\frac{c}{c'}$	t°	H_2O Layer (c)	Ether Layer (c')	$\frac{c}{c'}$
0.0202	0.0108	1.87	0	0.0089	0.0167	0.532
0.0119	0.0034	3.51	10	0.0127	0.0128	0.995
0.0066	0.00093	7.07	20	0.0165	0.0091	1.814
0.0035	0.00025	13.95	30	0.0196	0.0059	3.303
			35	0.0207	0.0048	4.32

FERRIC FERROCYANIDE $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$

A saturated solution in water at room temperature contains 6.4×10^{-6} moles Fe^{+++} per liter. (Tananaev, Glushkova and Seifer, 1956)

FERROUS CARBONATE FeCO_3

CO

100 gms. of a sat. solution of FeCO_3 in water at 18° and in contact with CO_2 at a pressure of 1 atmosphere contain 0.072 gm. FeCO_3 . At a pressure of 56 atmospheres of CO_2 , 0.077 gm. FeCO_3 are dissolved. (Haehnel, 1924)

SOLUBILITY OF FERROUS CARBONATE IN AQUEOUS SALT SOLUTIONS, BOTH
WITH AND WITHOUT THE PRESENCE OF CARBON DIOXIDE
(Ehlert and Hempel, 1912)

(Each mixture was 1000 cc in volume and was rotated constantly for 24 hours. Temp., probably 5-8.)

Aqueous Solution of:	SOLUBILITY IN PRESENCE OF CO_2 (2 atmospheres pressure)			SOLUBILITY IN ABSENCE OF CO_2		
	Gms. Salt per 1000 Gms. H_2O	Gms. FeCO_3 per 1000 cc Solvent		Gms. Salt per 1000 Gms. H_2O	Gms. FeCO_3 per 1000 cc Solvent	
Water alone	0	0	6.191	...	...
NaCl}	...	...	...	351.2	...	0.350
$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	86.9	5.840	...	...	...	...
"	700	4.555	...	...	...	...
"	1150	4.459	...	...	...	...
"	1437.5	4.693	...	...	...	...
"	1725	5.398	...	...	...	...
"	2300	9.052	2300	...	...	...
$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	137.7	7.943	137.7	...	...	4.205
"	Sat. at 14	9.578	Sat. at 14	...	...	0.701
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	105.3	6.242	105.3	Sat. at 14	...	0.934
"	Sat. at 14	7.392	Sat. at 14	...	...	1.467
				Sat. at 14	...	2.933

Fe FERRUM

CO FERROUS BICARBONATE $\text{Fe}(\text{HCO}_3)_2$

SOLUBILITY OF FERROUS BICARBONATE IN CARBONATED WATER AT 30°
(Smith, H. J., 1918)

Pure white ferrous carbonate was prepared by heating to 100° for several days in a steel bottle, an aqueous solution of ferrous sulfate, sodium bicarbonate and carbon dioxide (introduced at 400 lbs. pressure). The crystalline product was similar to the mineral siderite and was probably isomorphous with calcite. Fifty to one hundred gram portions were placed in a two-liter steel bottle, coated on the inside with a mixture of beeswax and Venice turpentine. Water was added and CO_2 introduced through a needle valve from a cylinder of the liquefied gas. The pressure was read on a gauge. The bottle was rotated at constant temperature for several days or until equilibrium was reached. The portion of the saturated solution for analysis was withdrawn through a brass tube attached to the valve on the inside of the bottle and packed with cotton to act as a filter. The filtered portion was received in a tared evacuated flask, containing a few cc of conc. H_2SO_4 . The CO_2 was determined by absorption and the iron by precipitation, resolution, reduction and titration with permanganate. The results show that the decomposition tension of $\text{Fe}(\text{HCO}_3)_2$ is greater than 25 atmospheres at 25°.

Gms. Mols. per Liter		Gms. per Liter		Gm. Mols. per Liter		Gms. per Liter	
H_2CO_3	$\text{Fe}(\text{HCO}_3)_2$	H_2CO_3	$\text{Fe}(\text{HCO}_3)_2$	H_2CO_3	$\text{Fe}(\text{HCO}_3)_2$	H_2CO_3	$\text{Fe}(\text{HCO}_3)_2$
0.1868	0.00245	11.58	0.436	0.3294	0.00311	20.43	0.553
0.1985	0.00256	12.31	0.455	0.3745	0.00315	23.23	0.560
0.2168	0.00262	13.45	0.466	0.4046	0.00332	25.09	0.590
0.2327	0.00274	14.43	0.487	0.4750	0.00348	29.45	0.619
0.2960	0.00303	18.35	0.539	0.6600	0.00402	40.93	0.715
0.3116	0.00304	19.32	0.541	0.7154	0.00418	44.36	0.744
0.3153	0.00318	19.55	0.566	0.7600	0.00434	47.13	0.772

CO FERROUS OXALATE FeC_2O_4

SOLUBILITY IN WATER DETERMINED BY ELECTROLYTIC CONDUCTIVITY

t°	Milligrams FeC_2O_4 per liter sat. sol.	Solid Phase	Authority
18	35.3	$\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	Scholder, Gadenne and Niemann, 1927
25	77.5	"	Schafer, 1905

FERRIC FORMATE (basic) $\text{Fe}_2(\text{OH})_2(\text{HCOO})_7 \cdot 4\text{H}_2\text{O}$

CH

SOLUBILITY IN WATER AND IN ABSOLUTE ALCOHOL
(Hampshire and Pratt, 1913)

Solubility in Water			Solubility in Abs. Alcohol	
t°	Gms. Salt per 100 Gms. H ₂ O	Solid Phase	t°	Gms. Salt per 100 Gms. C ₂ H ₅ OH
15	5.08	$\text{Fe}_2(\text{OH})_2(\text{HCOO})_7 \cdot 4\text{H}_2\text{O}$	19	4.59
20	5.52	"	22	6.225
25	6.10	"	23	7.62
30	6.78	"		
35	7.52	"		

(The sat. solutions are not stable.)

FERROUS $\left\{ \begin{array}{l} \text{Benzene} \\ \text{Naphthalene} \\ \text{Phenanthrene} \end{array} \right\}$ SULFONATES

SOLUBILITY OF EACH IN WATER

Compound	Formula	t°	Gms. anhydrous cmpd. per 100 cc sat. sol.	Authority
Ferrous benzene sulfonate	$\text{Fe}(\text{C}_6\text{H}_5\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	20	9.234	(Ephraim and Pfister, 1925)
Ferrous naphthalene-2-sulfonate	$\text{Fe}(\text{C}_{10}\text{H}_7\text{SO}_3)_2 \cdot 6\text{H}_2\text{O}$	16.5	0.243	(Ephraim and Pfister, 1925a)
" phenanthrene-2-sulfonate	$\text{Fe}(\text{C}_{14}\text{H}_9\text{SO}_3)_2 \cdot 5\text{H}_2\text{O}$	20	0.044	(Sandquist, 1912)
" " .3. "	"	20	0.20	(" ")
" " .10. "	"	20	0.16	(" ")

FERROUS PYRIDINE RHODINATE $\text{C}_5\text{H}_5\text{NFeCNS ?}$

CH

0.0136 mols are dissolved in one liter of a saturated solution in water. 0.0202 moles are dissolved in one liter of a saturated solution in Absolute Alcohol (probably at 20°) Treadwell and Ammann, 1938.

FERROUS ANTHRANILATE $\text{Fe}(\text{H}_2\text{NC}_6\text{H}_4\text{COO})_2$

0.0124 mols. are dissolved in one liter of a saturated solution which is 1N with Acetic Acid (probably at 20°) Treadwell and Ammann, 1938.

Fe FERRUM

FERRIC CUPFERRATE $\text{Fe}(\text{C}_6\text{H}_5\text{N}(\text{NO})\text{O})_3$ (Nitroso phenyl hydroxyl amine)

The solubility product was found to be 9.9×10^{-26} by Pyatnitski, 1946. Data for the extraction of ferric cupferrate by chloroform from 4M chloride solutions containing varying amounts of HCl are given by Sandell and Cummings, 1949.

One liter of Water dissolves 3.10^{-7} gm. atom (= 0.02 mgm.) of the compound at 18°. (Pinkus and Martin, 1927).

CH FERRIC TARTARATE

Extraction of Fe^{+++} by chloroform from solutions containing tartarate is "complete" at pH 2.5-12.5.

FERROUS CYSTEINATE $\text{Fe}(\text{OOCCH}_2(\text{NH}_2)\text{CH}_2\text{S})$

Tanaka, Kolthoff and Stricks (1955) found the Ksp to be 2.6×10^{-11} at 25° in solutions of pH 5-7.

FERROUS 8-OXYQUINOLATE (OXINE) $\text{Fe}(\text{C}_9\text{H}_6\text{ON})_2 \cdot 2\text{H}_2\text{O}$

0.00590 mols. are dissolved in one liter of a saturated solution which is 1N with Acetic Acid (probably at 20°) Treadwell and Ammann, 1938. Tinovskaya (1950) reports the Ksp to be 1.39×10^{-32} .

FERRIC 8-OXYQUINOLATE (OXINE) $\text{Fe}(\text{C}_9\text{H}_6\text{ON})_3$

The Ksp is about 10^{-47} (Sandell and Spindler, 1949).

A saturated solution is benzene at 25° yields a mole fraction of 0.00028 in solution. (Charles and Freiser, 1951)

Extraction of iron with chloroform from solutions containing 8 hydroxyquinoline is "complete" at pH 1.9-3.0 (Moeller, 1943).

CH FERROUS CAMPHOR-10-SULFONATE $\text{Fe}(\text{C}_{10}\text{H}_{15}\text{OSO}_3)_2$

At 15° a saturated solution in water contains 20% of the salt. (Pirrone, 1942)

FERROUS OLEATE

100 gms. glycerol ($d = 1.114$) dissolve 0.71 gm. ferrum oleate. (Asselin, 1873)

IRON HELIANTHATE (Ferrous and Ferric)

1000 cc H₂O dissolve 0.109 gm. Fe(C₁₄H₁₄N₃SO₃)₂·4H₂O(ous salt) at 20-25°.
 " " " " 0.118 " Fe(C₁₄H₁₄N₃SO₃)₃·6H₂O(ic salt) at 20-25°.
 (Stark and Dehn, 1918)

FERROUS CHLORIDE FeCl₂

SOLUBILITY OF FERROUS CHLORIDE IN WATER IN AN ATMOSPHERE
 OF CARBON DIOXIDE
 (Schimmel, 1928)

The data of Boecke, 1911 are too high.

t°	Gms. FeCl ₂ per 100 gms. sat. sol.	Solid Phase
- 9.0	14.5	Ice
-11.6	17.0	"
-13.3	17.7	"
-22.5	23.3	"
-29.0	26.6	"
-35.0	29.8	"
-38.0	30.85*	"
-40.0	31.8 *	"
-43.5	33.1 *	"
-50.0	35.5 *	"
-36.5	30.4	" + FeCl ₂ ·6H ₂ O
-20.0	31.0	FeCl ₂ ·6H ₂ O
-11.0	31.7	"
- 6.8	32.1	"
- 3.0	32.6	"
0.0	33.2 ^a	"
+ 1.5	33.6	"
5.0	34.65	"
8.0	36.7	"
12.3	37.6	FeCl ₂ ·6H ₂ O + FeCl ₂ ·4H ₂ O
16.0	38.0	FeCl ₂ ·4H ₂ O
20.0	38.5 ^a , b	"
20.5	38.6	"
25.0	39.2	"
	39.61 ^c	"
35.0	40.20 ^d	"
36.2	40.4	"
40.0	40.7 ^a	"
52.0	42.6	"
60.0	43.9 ^a	"
63.0	44.4	"
70.5	45.8	"
76.5	47.4	" + FeCl ₂ ·2H ₂ O
86.0	47.7	FeCl ₂ ·2H ₂ O
96	48.3	"
100	48.7 ^a	"
117.5	50.4	"

*Metastable

^aSchimmel, 1952; ^bSchafer, 1949 (d. sat. sol. = 1.443);

^cOsaka and Yuginuma, 1927; ^dLushnaya, 1949.

Fe FERRUM

SOLUBILITY OF FERROUS CHLORIDE IN HYDROCHLORIC ACID SOLUTIONS

Data of Schimmel, 1952 .

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
HCl	FeCl ₂	HCl		FeCl ₂			
Results at 0°				Results at 40°--Contd.			
Cl	0.0	33.2	6	15.6	18.3	4	
	0.6	32.1	"	19.3	13.55	"	
	10.8	17.2	"	24.25	10.0	"	
	15.6	12.1	"	25.5	9.3	"	
	17.0	11.2	6 + 4	26.3	8.9	"	
	17.4	10.45	4	26.75	8.8	4 + 2	
	19.3	7.95	"	29.85	5.8	2	
	19.9	7.21	"	32.8	4.4	"	
	24.1	4.34	"	Results at 60°			
	25.55	3.53	"	0.0	43.9	4	
	29.9	2.13	"	5.2	36.65	"	
	30.2	2.08	"	13.85	25.7	"	
	31.4	1.70	"	15.2	23.9	4 + 2	
Results at 20°				15.4	23.5	2	
0.0	38.5	"	15.5	23.3	"		
6.1	28.7	"	15.7	22.7	"		
12.0	19.4	"	16.3	21.8	"		
13.5	18.1	"	20.7	16.4	"		
17.9	12.8	"	26.5	10.35	"		
24.85	6.23	"	27.3	9.3	"		
30.0	4.35	"	Results at 100°				
31.6	4.00	4 + 2	0.0	48.7	2		
Results at 40°				1.3	46.4	"	
0.0	40.7	4	5.3	39.9	"		
5.25	32.9	"	11.05	31.05	"		
10.7	24.4	"	13.0	28.4	"		

Data of Schafer, 1949

Gms. per 100 gms. sat. sol.		Density	Solid Phase	Gms. per 100 gms. sat. sol.		Density	Solid Phase
HCl	FeCl ₂			HCl	FeCl ₂		
Results at 20°							
0.0	38.5	1.443	4	20.03	9.75	1.204	4
1.82	35.5	1.415	4	21.9	7.85	1.204	4
3.65	32.4	1.386	4	23.7	6.46	1.190	4
5.47	29.5	1.359	4	25.5	5.45	1.188	4
7.29	26.7	1.334	4	27.3	4.57	1.190	4
9.11	23.9	1.310	4	29.1	3.93	1.194	4
10.93	21.4	1.288	4	30.9	2.13	1.198	4 + 2
12.75	18.9	1.267	4	32.8	1.89	1.202	2
14.57	16.5	1.248	4	34.6	1.74	1.207	2
16.40	14.1	1.230	4	36.4	1.58	1.212	2
18.21	11.9	1.216	4				

6 = FeCl₂·6H₂O; 4 = FeCl₂·4H₂O; 2 = FeCl₂·2H₂O.

THE SYSTEM FERROUS CHLORIDE - FERRIC CHLORIDE - WATER AT 25°
(Schimmel, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
FeCl ₃	FeCl ₂		FeCl ₃	FeCl ₂	
39.2	0.0	Fe ₄	7.05	41.95	Fe ₄
35.9	4.1	"	5.44	46.65	Fe ₄ + Fe ₆
31.4	9.9	"	3.96	47.01	Fe ₆
22.8	19.46	"	3.49	47.41	"
14.45	30.4	"	0.0	49.7	"
8.3	39.8	"			

Cl

THE SYSTEM FERROUS CHLORIDE - AMMONIUM CHLORIDE - WATER

Results of Lushnaya, 1949 at 35°

Gms. per 100 gms. Saturated Solution		% FeCl ₂ in Mixed Crystals (Extrapolated)	Solid Phase
NH ₄ Cl	FeCl ₂		
30.35	0.0	0.0	NH ₄ Cl
27.94	4.85	1.2	α - SS
24.55	9.50	3.5	"
24.98	8.51	4.0	"
22.08	12.53	6.0	"
20.18	15.18	9.9	"
19.47	16.98	12.5	"
18.45	19.01	15.8	"
16.84	22.17	20.2	"
15.99	23.04	21.0	"
15.20	24.19	24.5	"
15.07	24.74	27.2	"
15.23	25.21	28.4	"
13.25	26.84	34.8	β - SS
11.36	29.38	38.5	"
9.72	30.87	43.3	"
8.68	33.04	48.3	"
6.72	35.55	50.8	"
5.49	38.47	52.5	"
4.96	39.62	61.5	" + Fe ₄
2.50	38.90	63.75	Fe ₄
0.0	40.20	-	"

SS = Solid Solution

Fe₄ = FeCl₂·4H₂O

Fe₆ = FeCl₃·6H₂O

(Cont.)

THE SYSTEM FERROUS CHLORIDE - AMMONIUM CHLORIDE - WATER--Contd.

Results of Clendinnen, 1922 at 70°

d of sat. sol.	Gms. per 100 gms. sat. sol.		% NH ₄ Cl in mixed crystals (extrapolated)
	NH ₄ Cl	FeCl ₂	
1.162	31.39	9.52	86.0
1.260	24.24	19.78	69.3
1.307	19.97	25.22	50.9
1.338	17.04	28.38	43.6
1.362	14.99	30.53	40.0
Cl 1.420	10.23	36.05	37.1
1.475	7.28	40.72	31.6
1.479	6.72	41.37	26.5
1.485	6.28	41.98	24.1
1.520	4.19	44.71	18.0
-	2.69	46.42	8.0
1.533	1.33	46.66	0.0

 THE SYSTEM FERROUS CHLORIDE - NICKEL CHLORIDE - WATER
 AT 25° IN AN ATMOSPHERE OF CO₂
 (Osaka and Yaginuma, 1927)

Solid FeCl₂·4H₂O is sat. when 10.6 per cent of the Fe is replaced by Ni and NiCl₂·6H₂O is sat. when 65.6 per cent of Ni is replaced by Fe. The liquid solution in equilibrium with the two sat. solid solutions contains 21.6 per cent FeCl₂ and 19.36 per cent NiCl₂.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
FeCl ₂	NiCl ₂		FeCl ₂	NiCl ₂	
39.61	0.0	FeCl ₂ ·4H ₂ O	21.56	19.42	Solid Solution
35.26	4.44	Solid Solution	16.25	24.03	"
29.82	10.52	"	9.26	30.68	"
22.72	17.61	"	0.0	38.88	NiCl ₂ ·6H ₂ O

Melting point data are given for the following systems:

FeCl ₂ + MnCl ₂	(Ferrari, Celeri and Giorgi, 1929)
" + PbCl ₂	(Ferrari and Colla, 1933)
" + SnCl ₂	(" " " ")
" + SrCl ₂	(Ferrari and Inganni, 1930)
" + ZnCl ₂	(" " " ")
" + FeCl ₃	(Schafer and Bayer, 1953)

FERRIC CHLORIDE FeCl_3

Cl

THE SYSTEM FERRIC CHLORIDE - WATER
(Rooseboom, 1892; Linke, 1956; Schafer, 1949)

Additional data are given in Rooseboom's paper. All the hydrates except $\text{FeCl}_3 \cdot 10\text{H}_2\text{O}$ melt congruently.

t°	Mols. FeCl ₃ per 100 Mols. H ₂ O	Gms. FeCl ₃ per 100 Gms.		t°	Mole. FeCl ₃ per 100 Mols. H ₂ O	Gms. FeCl ₃ per 100 Gms.	
		H ₂ O	Solution			H ₂ O	Solution
Solid phase ICE				Solid phase FeCl ₃ ·2.5 H ₂ O			
-10	.50	18.0	15.3	12	6.44	231.8	69.87
-20.5	.82	29.5	22.8	27	7.42	267.5	72.78
-27.5	.95	34.2	25.5	35	7.82	281.6	73.79
-32.1	-	38.7	27.9(L.)	50	8.75	315.2	75.91
-35.0e	-	40.3	28.7(L.)	55	9.58	344.8	77.52
-40	1.18	42.7	29.9*	55	10.16	365.9	78.54
-55	1.38	49.5	33.1*				
Solid phase FeCl ₃ ·10H ₂ O				Solid phase FeCl ₃ ·2H ₂ O			
-35.0e	-	-	28.7(L.)	50	9.98	359.3	78.23
-31.6	-	-	29.3(L.)	55	10.16	365.9	78.54
-20.0	-	-	32.0(L.)	60	10.35	372.8	78.86
-9.8	-	-	35.7(L.)	69	10.77	387.7	79.50
-6.4	-	-	37.3(L.)	73.5	12.5	450.2	81.81
-3.2	-	-	39.6(L.)	70	14.0	502.4	83.41
-0.4	-	-	42.0(L.)	66	14.6	525.9	84.03
0.0	-	-	42.4(L.)				
Solid phase FeCl ₃ ·6H ₂ O				Solid phase FeCl ₃			
-55	1.38	49.52	33.12*	66	14.6	525.9	84.03
-27	1.49	53.60	34.93*	75	14.46	511.4	83.66
0	2.06	74.39	42.66	80	14.60	525.9	84.03
+20	2.55	91.85	47.38	100	14.88	535.8	84.26
30	2.96	106.8	51.64		60.3	-	(S.)
37	4.16	150.0	60.01	120	64.1	-	(S.)
30	5.60	201.7	66.85	140	69.0	-	(S.)
20	6.42	231.1	69.79	160	74.6	-	(S.)
8	6.8	246.7	71.15	180	81.3	-	(S.)
				200	90.1	-	(S.)
				220	102.	-	(S.)
				240	119.	-	(S.)
				260	147.	-	(S.)
				280	222.	-	(S.)
				300	909.	-	(S.)
				305	∞ (m. pt.)	-	(S.)
Solid phase FeCl ₃ ·3.5H ₂ O							
20	5.68	204.4	67.14				
32	6.78	244.0	70.92				
30	7.56	272.4	73.13				
25	7.77	280.0	73.69				

*metastable

°eutectic

THE SYSTEM FeCl_3 - HCl - H_2O
(Results of Roozeboom and Schreinemakers, 1894)

More data at these and other temperatures are given in the original paper.

Mols. per 100 Mols. H_2O		Gms. per 100 Gms. H_2O		Solid Phase
HCl	FeCl_3	HCl	FeCl_3	
Results at 0°				
0	8.25	0	74.30	$\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$
7.52	6.51	15.22	58.62	
13.37	6.33	27.06	57.01	
16.80	8.70	33.99	78.34	
18.45	10.23	37.34	92.10	
20.40	15.40	41.28	138.7	
20.10	16.00	40.67	144.1	
19.95	17.70	40.37	159.4	
19.00	22.75	38.45	204.8	
18.05	23.41	36.53	210.8	
18.05	23.40	36.53	210.8	$\text{Fe}_2\text{Cl}_6 \cdot 7\text{H}_2\text{O}$
19.50	25.93	39.55	233.5	
24.12	30.04	48.81	270.5	$\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$
26.00	32.16	52.60	289.6	
26.00	32.16	52.60	289.6	$\text{Fe}_2\text{Cl}_6 \cdot 4\text{H}_2\text{O}$
34.60	38.11	70.01	343.2	
37.27	36.60	75.41	329.6	$\text{Fe}_2\text{Cl}_6 \cdot 2\text{HCl} + 4\text{H}_2\text{O}$
34.60	38.11	70.01	343.2	
Results at 25°				
0.0	10.90	0.0	98.15	$\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$
2.33	23.72	4.715	213.6	
0.0	24.5	0.0	220.7	
0.0	23.5	0.0	211.6	$\text{Fe}_2\text{Cl}_6 \cdot 7\text{H}_2\text{O}$
2.33	23.72	4.715	213.4	
7.50	29.75	15.18	267.9	
0.0	31.50	0.0	283.6	
0.0	29.00	0.0	261.1	$\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$
7.5	29.75	15.18	267.9	
19.5	35.25	39.46	317.4	
19.5	35.25	39.46	317.4	
20.6	35.34	41.68	318.3	$\text{Fe}_2\text{Cl}_6 \cdot 4\text{H}_2\text{O}$
31.34	41.58	63.42	374.4	
33.00	43.00	66.77	387.3	
34.65	44.80	70.11	403.4	
40.41	40.25	81.77	362.4	$\text{Fe}_2\text{Cl}_6 \cdot 2\text{HCl} + 4\text{H}_2\text{O}$
39.03	41.38	78.98	372.7	
35.74	45.24	72.33	407.4	

(Cont.)

THE SYSTEM FeCl_3 - HCl - H_2O --Contd.

Results at 40°

Mols. per 100 Mols. H_2O		Gms. per 100 Gms. H_2O		Solid Phase
HCl	FeCl_3	HCl	FeCl_3	
0	32.4	0.0	291.7	$\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$
13.4	37.45	27.11	337.3	
13.4	37.45	27.11	337.3	
27.0	50.80	54.64	457.5	$\text{Fe}_2\text{Cl}_6 \cdot 4\text{H}_2\text{O}$
0	58.0	0.0	522.3	
27	50.8	54.64	457.5	Fe_2Cl_6
42.01	48.64	85.00	438.0	
42.50	47.52	86.72	428.0	$\text{Fe}_2\text{Cl}_6 \cdot 2\text{HCl} + 4\text{H}_2\text{O}$
42.01	48.64	85.00	438.0	

(Results of Linke, 1956)

Additional data are given in the original paper.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
FeCl_3	HCl	Solid Phase	FeCl_3	HCl	Solid Phase	FeCl_3	HCl	Solid Phase
Data at -20°			18.37	15.39	Fe-10	19.39	19.20	Fe6
			22.70	13.51	"	20.25	21.01	"
32.00	0.0	Fe-10	22.69	14.15	"	24.35	21.91	"
27.77	3.61	"	24.59	13.09	"			
25.45	5.80	"	38.35	0.0	Fe6	Data at -31.6°		
19.17	11.86	"	27.11	10.08	"			
19.65	12.21	"	25.04	12.01	"	13.14	23.1	Fe6
19.35	14.22	"	23.03	14.79	"	16.14	27.2	"
19.43	14.56	"	22.15	15.30	"			

 $\text{Fe10} = \text{FeCl}_3 \cdot 10\text{H}_2\text{O}$; $\text{Fe6} = \text{FeCl}_3 \cdot 6\text{H}_2\text{O}$.

(Results of Cameron and Robinson, 1907 at 2.5°)

(Excess of ferric hydroxide was added to aq. ferric chloride solutions and agitated for 3 months.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	d_{25} of sat. sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
Fe_2O_3	HCl			Fe_2O_3	HCl	
34.61	59.88	$\text{FeCl}_3 \cdot \text{HCl} \cdot 2\text{H}_2\text{O}$	1.485	21.84	29.33	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O} + \text{Fe}_2\text{O}_3 \cdot x\text{HCl} \cdot \text{H}_2\text{O}$
33.27	60.23	"	1.349	16.82	22.55	"
32.78	54.71	" + FeCl_3	1.321	15.83	21.10	"
31.95	58.20	$\text{FeCl}_3 + \text{FeCl}_3 \cdot 2\text{H}_2\text{O}$	1.284	14.62	19.53	"
34.42	54.12	$\text{FeCl}_3 \cdot 2\text{H}_2\text{O}$	1.242	12.59	16.61	"
35.22	59.28	"	1.220	11.76	15.28	"
34.07	55.71	"	1.195	10.56	13.76	"
34.21	55.47	" + $\text{FeCl}_3 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	1.158	8.60	11.24	"
34.44	51.11	$\text{FeCl}_3 \cdot 3\frac{1}{2}\text{H}_2\text{O} + "$	1.115	6.47	8.39	"
33.04	46.72	" + $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	1.070	4.04	5.36	"
24.42	33.40	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	1.047	2.85	3.66	"

(Cont.)

Fa FERRUM

(Results of Kurnakov and Nikitina, 1938)

[SOLID PHASE = ICE]

t°	Mols. per 100 mols. FeCl ₃ + HCl + H ₂ O		t°	Mols. per 100 mols. FeCl ₃ + HCl + H ₂ O	
	FeCl ₃	HCl		FeCl ₃	HCl
-25	0.0	7.81	-15	0.0	5.20
	2.79	1.50		0.76	3.44
	2.82	3.38		1.33	2.07
	3.46	0.0		2.42	0.0
	0.0	6.14		0.0	4.01
-20	1.04	4.16	-10	0.51	2.89
	2.29	1.10		1.71	0.28
	2.75	1.55		1.93	0.0
	2.99	0.0		0.0	2.42
				1.35	0.0

A theoretical discussion of the system ferric chloride, ferric oxide and water, especially of the phase diagram above 400°, is given by Baur, 1926.

Data on the basic salts in the system FeCl₃ - Fe₂O₃ - (CaCl₂) - H₂O are given by Bolko, 1955.

THE SYSTEM FERRIC CHLORIDE - CESIUM CHLORIDE - WATER AT 21°
(Hinrichsen and Sachael, 1904-05)

"Gms. Used"		Gms. per 100 Gms. H ₂ O		Gms. Mols. per 100 Mols. H ₂ O		Solid Phase
FeCl ₃	CsCl	FeCl ₃	CsCl	FeCl ₃	CsCl	
0	65	0	65	0	6.95	CsCl
0.6	11.0	0.45	55.18	0.05	5.9	FeCl ₃ ·3CsCl·H ₂ O
1.4	10.2	2.10	52.38	0.23	5.6	"
2.2	8.8	5.24	51.44	0.57	5.5	"
2.0	7.4	7.80	47.70	0.86	5.1	FeCl ₃ ·2CsCl·H ₂ O
3.8	6.0	8.93	41.15	0.99	4.4	"
4.6	4.6	15.34	25.25	1.70	2.7	"
5.4	2.8	21.65	14.96	2.40	1.6	"
6.2	1.4	27.96	8.42	3.10	0.9	"
35	0.2	48.71	0.94	5.40	0.1	"
35	0	83.89	0	9.3	0	FeCl ₃

THE SYSTEM $\text{FeCl}_3 - \text{KCl} - \text{HCl} - \text{H}_2\text{O}$ AT 25°
(Malquori, 1929)

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
KCl	FeCl_3	HCl		KCl	FeCl_3	HCl	
11.997	35.88	0.0	A + B	1.15	69.10	3.15	D + E + B
1.50	1.15	39.20	A + B	0.0	69.47	8.63	E + F
1.22	49.33	0.0	B + C	1.27	68.87	8.20	E + F + B
0.0	67.13	11.48	C + D	0.0	70.30	12.30	F + G
1.10	66.91	1.27	C + D + B	1.71	70.10	11.85	F + G + B
0.0	69.93	3.96	D + E				

A = KCl

B = $\text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O}$ C = $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ D = $\text{FeCl}_3 \cdot 3\frac{1}{2}\text{H}_2\text{O}$ E = $\text{FeCl}_3 \cdot 2\frac{1}{2}\text{H}_2\text{O}$ F = $\text{FeCl}_3 \cdot 2\text{H}_2\text{O}$ G = $\text{FeCl}_3 \cdot \text{HCl} \cdot 2\text{H}_2\text{O}$

Cl

THE SYSTEM FERRIC CHLORIDE - POTASSIUM CHLORIDE - WATER

The data of Hinrichsen and Sachsels, 1904-5 are unreliable.

Results of Malquori, 1928a

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
KCl	FeCl_3			KCl	FeCl_3		
Results at 0°				Results at 35°			
0.0	42.66		Fe6	0.0	73.79		Fe ₂ 5
1.07	42.53		" + 1.2.2	1.65	73.03		" + 1.2.1
2.85	38.55		1.2.1	2.21	65.81		1.2.1
6.03	35.67		" + MC	2.35	57.53		"
6.18	38.12		MC	3.52	49.57		"
6.14	33.54		"	5.05	45.94		"
6.22	28.85		"	8.60	40.25		"
6.73	25.78		"	13.81	36.02		1.2.1 + KCl
7.54	23.25		"	13.11	34.44		KCl
10.19	16.38		"	14.02	29.21		"
21.60	0.0		KCl	16.82	20.12		"
				20.21	10.91		"
				27.80	0.0		"
Results at 25°				Results at 60°			
0.0	49.76		Fe6				
1.22	49.33		" + 1.2.1				
2.01	47.27		1.2.1	0.0	78.80		Fe2
5.65	43.02		1.2.1	1.90	77.13		" + 1.2.1
10.29	38.02		"	2.25	74.08		1.2.1
11.97	35.88		" + KCl	3.10	61.70		"
12.26	27.27		KCl	4.96	53.98		"
14.99	22.14		"	14.41	36.78		" + KCl
17.40	14.90		"	16.30	28.73		KCl
26.02	0.0		"	31.30	0.0		"

Fe6 = $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$; 1.2.1 = $\text{FeCl}_3 \cdot 2\text{KCl} \cdot \text{H}_2\text{O}$; Fe₂5 = $\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$;Fe2 = $\text{FeCl}_3 \cdot 2\text{H}_2\text{O}$; MC = Mixed Crystals.

Fe FERRUM

Results of Luahnaya, 1950 at 35°

Read from a plot of the data, differing somewhat from those above.

Gms. per 100 gms. sat. sol.

Gms. per 100 gms. sat. sol.		Solid Phase
KCl	FeCl ₃	
15.0	17.0	KCl
11.5	32.0	KCl + FeCl ₃ ·2KCl·H ₂ O
5.0	44.0	FeCl ₃ ·2KCl·H ₂ O
3.5	51.5	FeCl ₃ ·2KCl·H ₂ O + FeCl ₃ ·6H ₂ O

C1 THE SYSTEM FERRIC CHLORIDE - SODIUM CHLORIDE - WATER
(Linke, 1958)

The data of Hinrichsen and Sachsel (1904-05), which seem to indicate solid solution formation, are incorrect.

Gms. per 100
gms. sat. sol.

Gms. per 100 gms. sat. sol.		Density	Solid Phase
FeCl ₃	NaCl		
Results at -20°			
12.02	13.70	-	NaCl·2H ₂ O
21.39	8.68	-	"
32.00	3.88 ^M	-	"
35.27	2.90 ^M	-	"
29.75	4.73	-	NaCl·2H ₂ O + FeCl ₃ ·10H ₂ O
30.18	5.07	-	" + "
30.40	4.45	-	" + "
29.65	4.48	-	FeCl ₃ ·10H ₂ O
29.68	4.48	-	"
30.75	3.18	-	"
31.10	2.10	-	"
32.00	0.0	-	"
10.48	12.15	-	Ice
Results at 0°			
0.0	25.97	1.218	NaCl
4.86	22.27	1.219	"
13.00	16.02	1.242	"
21.75	10.18	1.283	"
33.61	4.35	1.363	"
36.50	3.51	1.413	"
40.42	3.03	1.423	"
37.31	3.27	-	"
43.12	2.00 ^M	-	"
41.33	2.56	-	NaCl + FeCl ₃ ·6H ₂ O
41.50	2.28	1.467	" + "
41.22	2.73	1.462	" + "
41.30	2.59	1.467	" + "
42.40	0.0	-	FeCl ₃ ·6H ₂ O

M = metastable

(Cont.)

THE SYSTEM FERRIC CHLORIDE - SODIUM CHLORIDE - WATER--Contd.

Results at 25°

Gms. per 100 gms. sat. sol.		Density	Solid Phase	
FeCl ₃	NaCl			
0.0	26.39	1.196	NaCl	
4.79	22.87	1.217	"	
8.35	20.48	1.225	"	
12.80	17.28	1.247	"	
21.48	11.94	1.300	"	
32.95	6.20	1.386	"	Cl
39.79	3.99	1.460	"	
42.90	3.31	1.492	"	
43.72	3.12	1.507	"	
46.52	2.56	1.543	"	
47.45	2.32	1.555	"	
48.58	2.15	1.568	NaCl + FeCl ₃ ·6H ₂ O	
48.55	2.19	1.569	" + "	
48.65	1.87	1.567	FeCl ₃ ·6H ₂ O	
49.38	0.0	1.556	"	

THE SYSTEM FERRIC CHLORIDE - AMMONIUM CHLORIDE - WATER

The double salt FeCl₃·2NH₄Cl·H₂O forms limited solid solutions with each of its components. The tie lines show a narrow series of solid solutions whose compositions approximate the 1:2:1 compound.

Data of Roozeboom, 1892 at 15°

Grams per 100 Gms. H ₂ O		Solid Phase
NH ₄ Cl	FeCl ₃	
0.0	83.88	FeCl ₃ ·6H ₂ O
3.24	86.32	"
4.03	91.61	" + FeCl ₃ ·2NH ₄ Cl·H ₂ O
5.92	83.64	FeCl ₃ ·2NH ₄ Cl·H ₂ O
8.31	78.77	"
12.08	73.20	"
19.12	64.83	"
32.04	56.00	"
23.21	60.83	Solid Sol'n. containing 7.39% FeCl ₃
22.63	53.47	" " " 5.55 "
22.90	45.42	" " " 4.4 "
23.23	39.13	" " " 3.8 "
25.33	25.43	" " " 1.64 "
32.55	6.15	" " " 0.31 "
35.30	0.0	NH ₄ Cl

(Cont.)

Fe FERRUM

(Contd.)

Data of Mohr, 1898

Results at 25° Results at 35° Results at 45°

	Mols. per 100 Mols. H ₂ O		Mols. per 100 Mols. H ₂ O		Mols. per 100 Mols. H ₂ O		Solid Phase in Each Case
	NH ₄ Cl	FeCl ₃	NH ₄ Cl	FeCl ₃	NH ₄ Cl	FeCl ₃	
Cl	0	10.98	0	13.30	0.0	33.4	FeCl ₃ ·6H ₂ O (2.5H ₂ O at 45°)
	1.57	10.74	1.41	13.05	...	...	Hydrate + Double Salt
	2.48	9.02	3.08	9.28	4.08	9.58	Double Salt
	5.28	7.73	6.98	7.64	...	...	"
	9.59	6.77	10.76	6.70	13.09	6.31	"
	9.83	6.70	11.60	6.52	13.54	6.28	Double Salt + Mixed Crystals
	9.65	6.07	12.28	6.08	12.91	5.49	Mixed Crystals
	9.93	5.23	11.57	3.98	13.49	4.84	"
	9.92	3.97	11.89	3.38	13.46	4.99	"
	10.31	2.05	13.23	1.38	...	...	"
	13.30	0.0	14.79	0.0	16.28	0.0	NH ₄ Cl

Data of Clendinnen, 1923

Results at 25°

d ₂₅ of sat. sol.	Gms. per 100 gms. sat. sol.		
	NH ₄ Cl	FeCl ₃	
1.132	24.14	7.64	Mixed crystals Series AB
1.177	21.19	13.26	
1.228	18.54	19.27	
1.327	16.05	28.97	
1.358	16.63	30.45	B and C
1.356	15.59	31.61	
1.369	13.41	33.46	Mixed crystals Series CD
1.412	8.70	38.10	
1.455	5.13	42.82	
1.513	2.93	47.63	
1.536	2.29	49.50	D + FeCl ₃ ·6H ₂ O
1.525	1.30	48.80	
1.133	31.37	7.75	Mixed crystals Series AB
1.268	25.40	22.95	
1.298	24.73	25.78	
1.310	22.49	27.47	
1.418	10.57	39.20	Mixed crystals Series CD
1.534	4.56	53.10	
1.639	8.85	65.08	
1.643	9.50	65.30	
1.620	8.57	65.70	D + NH ₄ Cl·FeCl ₃
1.677	3.78	69.47	
1.745	1.57	75.37	
1.793	0.40	77.36	
-	0.18	78.20	NH ₄ Cl·4FeCl ₃ ·6H ₂ O " + FeCl ₃ ·2H ₂ O
1.798	0.00	78.42	

(Cont.)

Distribution ratios for iron in the system $\text{FeCl}_3 + \text{NH}_4\text{Cl} + \text{H}_2\text{O}$ at 0° were obtained by Ioffe and Nikitin, 1942 by precipitating the mixed crystals from solutions containing definite concentrations of iron.

THE SYSTEM FERRIC CHLORIDE - NICKEL CHLORIDE - WATER AT 25°
(Osaka and Yaginuma, 1928)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	
FeCl_3	NiCl_2		FeCl_3	NiCl_2		
49.42	0.0	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	37.47	11.81	$\text{NiCl}_2 \cdot 4\text{H}_2\text{O}$	
46.08	4.37	"	31.35	16.43	"	Cl
43.39	6.80	"	29.77	18.11	"	
41.01	10.01	"	26.41	19.80	" + $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$	
46.24	7.33*	$\text{NiCl}_2 \cdot 4\text{H}_2\text{O}$	22.68	22.21	$\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$	
42.22	9.89*	"	10.24	30.89	"	
40.63	10.71	" + $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	0.0	38.88	"	

*Metastable

THE SYSTEM FERRIC CHLORIDE - ANILINE HYDROCHLORIDE -
HYDROCHLORIC ACID - WATER AT 25°
(Osaka, Shima and Yoshida, 1924)

The mixtures were constantly rotated at 25° . Both the liquid phase and the solid residues were analyzed.

Gms. per 100 gms. sat. sol.			Solid Phase
$\text{C}_6\text{H}_5\text{NH}_2 \cdot \text{HCl}$	FeCl_3	HCl	
11.29	0.20	21.20	-
12.46	0.49	19.57	-
10.77	0.11	21.64	-
8.94	1.35	19.41	-
7.11	0.69	22.48	-
5.85	1.10	23.87	-
5.05	1.86	22.03	-
4.61	3.01	22.28	-
3.99	3.35	23.04	-
4.05	3.58	22.35	-
5.59	6.37	19.17	-
3.44	6.31	22.36	-
22.78	0.0	11.08	$\text{FeCl}_3 \cdot 6\text{C}_6\text{H}_5\text{NH}_2 \cdot \text{HCl}$
20.24	1.29	11.78	"
18.09	1.03	13.02	"
19.59	1.31	12.08	"
17.19	2.82	11.88	"
13.81	5.18	11.32	"
10.92	8.51	10.82	"
8.85	8.83	12.66	"
7.06	12.12	11.44	"

(Cont.)

Fe FERRUM

THE SYSTEM FERRIC CHLORIDE - ANILINE HYDROCHLORIDE -
HYDROCHLORIC ACID - WATER AT 25°--Contd.

Gms. per 100 gms. sat. sol.

	$C_6H_5 \cdot NH_2 \cdot HCl$	$FeCl_3$	HCl	Solid Phase
Cl	7.09	14.30	10.21	$FeCl_3 \cdot 6C_6H_5NH_2 \cdot HCl$
	5.29	16.06	11.69	"
	4.49	18.16	11.91	"
	3.96	19.95	11.49	"
	3.07	21.50	12.89	"
	3.46	22.84	11.22	"
	3.47	23.82	10.21	"
	2.58	23.36	12.96	$FeCl_3 \cdot 2C_6H_5NH_2 \cdot HCl$
	2.10	25.59	12.48	"
	2.07	26.20	12.53	"
	1.77	28.61	11.71	"
	1.35	33.10	10.98	"
	1.57	35.17	7.22	-
	1.34	36.24	7.52	

DISTRIBUTION OF FERRIC CHLORIDE BETWEEN WATER AND ETHYL ETHER

Results of De Kolossowsky, 1925 at 18°

Gm. mols. $FeCl_3$ per liter		Gm. mols. $FeCl_3$ per liter	
H_2O Layer	$(C_2H_5)_2O$ layer	H_2O Layer	$(C_2H_5)_2O$ layer
1.017	0.00216	2.158	0.313
1.100	0.00259	2.210	0.579
1.217	0.00382	2.213	0.704
1.404	0.0048	2.442	0.837
1.420	0.0068	2.455	0.888
1.515	0.0080	2.389	0.868
1.504	0.0117	2.432	0.925
1.624	0.0163	2.833	1.281
1.907	0.0617	2.873	1.371
2.062	0.110	3.581	1.939

Results of Mylius, 1911 at 18°

One-gram portions of iron as chloride were dissolved in 100 cc of aq. HCl of different concentrations and shaken with 100 cc of ether in each case. The percentage of iron in the ethereal layer was determined after separation of the two layers.

Per cent conc. of Aq. HCl	1	5	10	15	20
Per cent of Iron Extracted by Ether	(0.01)	0.1	8	92	99

Additional data are given by Dodson, Forney, and Swift, 1936 and by Chalkey and Williams, 1955.

DISTRIBUTION OF FERRIC CHLORIDE BETWEEN
AQUEOUS HYDROCHLORIC ACID AND DICHLORDIETHYL ETHER AT 25°
(Axelrod and Swift, 1940)

Moles per liter in H ₂ O phase HCl		Fe ⁺⁺⁺	Distribution ratio Fe - Ether Fe - H ₂ O	
Initial	Final	Initial		
3.45	3.42	0.00895	0.065	
4.24	4.19	.00895	.187	
4.31	4.26	.00895	.186	
5.17	5.10	.00895	.81	
6.03	5.93	.00895	3.64	
6.90	6.77	.00895	17.8	Cl
7.75	7.58	.00895	-	
2.99	2.97	.0720	0.013	
4.00	3.95	.0720	.066	
4.20	4.14	.0720	.071	
4.00	4.93	.0720	.294	
5.17	5.09	.0720	.374	
5.99	5.88	.0720	1.32	
7.00	6.84	.0720	7.74	
7.99	7.80	.0720	29.8	
9.00	8.75	.0720	51.	
9.99	9.65	.0720	132.	
3.45	3.40	.574	0.043	
4.24	4.15	.574	.136	
5.17	5.02	.574	.350	
6.03	5.66	.574	1.06	
6.90	6.64	.574	2.88	
8.63	8.33	.574	19.4	

DISTRIBUTION OF FeCl₃ BETWEEN AQUEOUS HYDROCHLORIC ACID
SOLUTIONS AND ISOPROPYL ETHER AT 20°
(Nachtrieb and Fryxell, 1948)

5 ml. of HCl + FeCl₃ of known concentration were shaken with 5 ml. of Isopropyl Ether in a thermostat. Radioactive Iron was used, and the amount of Iron in each phase was determined by counting the emanations with a Geiger-Muller tube. Data on this system are also given by Dodson, Forney and Swift, 1936 and Myers, Metzler and Swift, 1950.

The concentrations are expressed in gm. mols. per liter of solution.

$$K = \frac{[\text{Fe}^{+++}] \text{ in Ether layer}}{[\text{Fe}^{+++}] \text{ in Water layer}}$$

Initial Concentration			Initial Concentration		
HCl	FeCl ₃	K	HCl	FeCl ₃	K
3.0	0.00339	0.00234	3.0 (contd.)	.06073	.00319
	.00865	.00252		.2059	.00961
	.02066	.00233		.2059	.0084
	.02066	.00253		.5064	.1606
	.06073	.00342		.5064	.175

(Cont.)

Fe FERRUM

DISTRIBUTION OF FeCl_3 BETWEEN AQUEOUS HYDROCHLORIC ACID SOLUTIONS AND ISOPROPYL ETHER AT 20° --Contd.

Initial Concentration			Initial Concentration		
HCl	FeCl_3	K	HCl	FeCl_3	K
4.0	0.0002258	0.0468	6.0	.0002258	4.367
	.001129	.0525		.0002258	3.653
	.00564	.0347		.001129	3.459
	.02066	.0463		.00564	4.538
	.05171	.0670		.00564	3.771
	.2059	.4685		.00764	2.598
	.4663	1.878		.00764	4.258
	0.0002258	0.389		.01566	6.050
	.001129	.370		.03569	15.18
	.00564	.300		.1238	42.95
Cl 5.0	.00564	.4585	7.0	.3061	81.69
	.00564	.475		0.0002258	29.81
	.00865	.588		.0004516	24.05
	0.02066	0.781		.001129	19.77
	.04370	2.621		.00564	28.39
	.1559	6.133		.01072	50.52
	.3862	12.41		.02567	128.7
				.05572	191.9
				.1058	279.0
				.2059	659

Results with Solutions Containing AlCl_3

Initial Concentration				Initial Concentration			
HCl	AlCl_3	FeCl_3	K	HCl	AlCl_3	FeCl_3	K
4.500	0.500	0.0	-	0.0	.480	.0200	7.16
	.499	.00100	2.00		.470	.0300	9.03
	.498	.00200	2.47		.450	.0500	11.4
	.497	.00300	2.41		.400	.1000	14.9
	.495	.00500	3.04		.300	.2000	17.2
	.490	.0100	3.45		.200	.3000	10.5
	.490	.0100	4.49		.500		3.92

Data for the distribution of Ferric Chloride between 5M Hydrochloric Acid and Isopropyl Ether saturated with $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$ at 25° are given by Nachtrieb and Fryxell, 1952. Three liquid layers appear in the system.

SOLUBILITY OF FERRIC CHLORIDE IN METHYL AND ETHYL ALCOHOLS
(Lloyd, Brown, Glynwyn, Bonnel and Jones, 1928)

At ordinary temperatures and more rapidly at higher temperatures ferric chloride reacts with methyl and with ethyl alcohol, hence solubility values for it can be accepted only with reserve.

The results in parentheses are for solutions in contact with FeCl_3 , 100 gms. U.S.P. Ethyl Alcohol (d_{40}^{25} 0.8063 = 93.6 Wt. %) dissolve 51.43 gms. FeCl_3 at 25°. (Schnellbach and Rosin, 1931)

Results for Methyl Alcohol		Results for Ethyl Alcohol		
t°	Gms. FeCl_3 per 100 gms. CH_3OH	t°	Gms. FeCl_3 per 100 gms. $\text{C}_2\text{H}_5\text{OH}$	Solid Phase
0	131	0	136	$\text{FeCl}_3 \cdot 2\text{C}_2\text{H}_5\text{OH}$
15	143	15	141	"
30	161	20.6	144 (199)	"
		30	149 (203)	"
		40	155 (207)	"
		50	176	"

C1

SOLUBILITY OF FERRIC CHLORIDE IN OTHER SOLVENTS

Solvent	t°	Solubility	Author
Acetone	18	62.9 gms. FeCl_3 per 100 gms. solvent	Naumann, 1904
Furfural	25	0.55 " " per 100 gms. sat. sol.	Trimble, 1941
Anhyd. Lanolin (m.p. 46°)	45	4.17 " " per 100 gms. solvent	Klose, 1907
SeOCl_2	25	23.4 " " per 100 gms. sat. sol.	Wise, 1923
S_2Cl_2 or SCl_2	20-30	less than 1 mg. %	Ionescu and Piatkowski, 1939
	60-100	less than 2 mg. %	

Melting point data are given for:

FeCl_3 + PbCl_2	(Herrmann, 1911)
" + ZnCl_2	(" ")
" + TlCl	(Scarpa, 1912)
" + NaCl	(Johnstone, Weingartener and Winsche, 1942)

FERROUS PERCHLORATE $\text{Fe}(\text{ClO}_4)_2$

C10

SOLUBILITY OF FERROUS PERCHLORATE IN WATER IN AN ATMOSPHERE OF NITROGEN (Lindstrand, 1936)

Although there is a slight break in the curve at 42°, an analysis showed no alteration in the solid phase.

d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_2$ per 100 gms. sat. sol.	Solid Phase	d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_2$ per 100 gms. sat. sol.	Solid Phase
0 1.543	63.39	$\text{Fe}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$	42 1.569	71.05	$\text{Fe}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$
20 1.560	66.93	"	45 1.571	71.55	"
25 1.565	67.76	"	50 1.574	72.19	"
30 1.569	68.67	"	55 1.577	72.84	"
35 1.573	69.48	"	60 1.580	73.49	"
40 1.577	70.34	"			

SOLUBILITY OF FERROUS PERCHLORATE IN AQUEOUS SOLUTIONS OF
PERCHLORIC ACID AT 20°
(Lindstrand, 1936)

The solid phase is $\text{Fe}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$ in all cases.

Mols. HClO_4 per liter sat. sol.	d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_2$ per 100 gms. sat. sol.	Mols. HClO_4 per liter sat. sol.	d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_2$ per 100 gms. sat. sol.
0.0	1.554	67.18	7.98	1.509	1.70
2.45	1.551	46.48	9.30	1.553	1.14
4.69	1.477	26.21	10.24	1.616	1.21
5.90	1.457	15.18	11.06	1.654	1.56
7.01	1.455	6.40			

SOLUBILITY IN ETHANOL

100 gms. of a saturated solution of Ferrous Perchlorate in Ethyl Alcohol contain 67.2 gms. $\text{Fe}(\text{ClO}_4)_2$ at 20°, d. of the sat. sol. = 1.290.
(Lindstrand, 1936)

Cl FERROUS Hexa Antipyrine PERCHLORATE $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$

100 cc sat. solution of the Salt in Water at 20° contain more than 7.0 gms. $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{ClO}_4)_2$. Due to the rapid oxidation of the compound the value is only approximate. (Wilke-Dorfurt and Schliephake, 1929)

FERRIC Hexa Antipyrine BICHROMATE $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{Cr}_2\text{O}_7)_3$

100 cc sat. solution of the compound in water contain 0.6 gm. $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{Cr}_2\text{O}_7)_3$ at 20°. (Wilke-Dorfurt and Mureck, 1929)

ClO FERRIC PERCHLORATE $\text{Fe}(\text{ClO}_4)_3$

SOLUBILITY OF FERRIC PERCHLORATE IN WATER
(Lindstrand, 1936)

d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_3$ per 100 gms. sat. sol.	Solid Phase	d. of sat. sol.	Gms. $\text{Fe}(\text{ClO}_4)_3$ per 100 gms. sat. sol.	Solid Phase
0 1.613	74.32	$\text{Fe}(\text{ClO}_4)_3 \cdot 10\text{H}_2\text{O}$	42 1.688	83.19	$\text{Fe}(\text{ClO}_4)_3 \cdot 10\text{H}_2\text{O}$
20 1.649	78.64	"	45 1.693	83.76	$\text{Fe}(\text{ClO}_4)_3 \cdot 9\text{H}_2\text{O}$
25 1.656	79.86	"	50 1.700	85.50	"
30 1.666	80.84	"	55 1.707	87.07	"
35 1.676	81.74	"	60 1.714	88.53	"
40 1.684	82.70	"			

SOLUBILITY OF FERRIC PERCHLORATE IN AQUEOUS
SOLUTIONS OF PERCHLORIC ACID AT 20°
(Lindstrand, 1936)

d. of sat. sol.	Gm. Mols. HClO ₄ per liter sat. sol.	Gm. Mols. Fe(ClO ₄) ₃ per-liter sat. sol.	Gms. Fe(ClO ₄) ₃ per 100 gms. sat. sol.	Solid Phase
1.649	0.0	2.427	78.64	Fe(ClO ₄) ₃ ·10H ₂ O
1.629	1.72	1.971	64.65	"
1.611	3.11	1.589	52.73	"
1.597	3.81	1.400	46.83	"
1.590	4.65	1.179	39.64	"
1.559	6.15	0.772	26.47	"
1.563	7.76	0.343	11.72	"
1.579	9.19	0.127	4.25	Fe(ClO ₄) ₃ ·9H ₂ O
1.626	10.57	0.084	2.67	"
1.713	11.10	0.066	1.99	"
1.766	13.35	0.025	0.73	"

SOLUBILITY IN ETHANOL

100 gms. sat. solution of Ferric Perchlorate in Ethyl Alcohol contain 71.3 gms. Fe(ClO₄)₃ at 20°; d. of sat. sol. = 1.359. (Lindstrand, 1936)

FERRIC Hexa Antipyrine PERCHLORATE [Fe(COC₁₀H₁₂N₂)₆](ClO₄)₃

ClO

100 cc sat. solution of the Salt in Water at 20° contain 0.24 gm. [Fe(COC₁₀H₁₂N₂)₆](ClO₄)₃. (Wilke-Dorfurt and Schliephake, 1929)

FERROUS FLUORIDE FeF₂

F

SOLUBILITY IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

t°	-22.5°	-4.5°	+11.8°
Gms. FeF ₂ per 100 gms. HF	0.005 ± .002	0.005 ± .002	0.006 ± .002

FERRIC FLUORIDE FeF₃

F

SOLUBILITY OF FERRIC FLUORIDE IN WATER
(Tananaev and Deichman, 1946)

100 grams of a saturated solution in water at 25° contain 5.59 gms. FeF₃. The saturating solid phase is FeF₃·3H₂O. This value does not agree with that of Carter (1918) who found 0.091 gm. FeF₃ per 100 cc sat. sol. at 25°.

Fe FERRUM

THE SYSTEM FERRIC FLUORIDE - HYDROGEN FLUORIDE - WATER AT 25° (Tananaev and Deichman, 1946)

Silver Vessels were used.

	Gms. per 100 gms. Saturated Solution		Solid Phase	Gms. per 100 gms. Saturated Solution		Solid Phase
	HF	FeF ₃		HF	FeF ₃	
	0.0	5.59	FeF ₃ ·3H ₂ O	45.03	10.82	FeF ₃ ·3H ₂ O
	1.14	5.01	"	45.21	14.95	"
	1.70	5.58	"	45.35	12.07	"
	3.16	6.16	"	45.50	14.52	"
F	6.24	5.54	"	46.00	16.73	FeF ₃ ·3H ₂ O + FeF ₃ ·3HF·3H ₂ O
	9.94	5.31	"			FeF ₃ ·3HF·3H ₂ O
	13.26	4.70	"	46.65	16.50	"
	15.71	4.43	"	47.62	12.97	"
	18.26	4.19	"	49.90	9.90	"
	21.40	3.76	"	50.12	10.67	"
	26.94	3.71	"	52.69	8.22	"
	33.53	3.91	"	54.15	7.53	"
	43.81	9.44	"	55.60	5.70	"
	44.60	9.56	"	61.23	3.22	"
	44.59	10.81	"	64.37	3.13	"
	44.72	10.96	"	70.98	1.06	"

THE SYSTEM FERRIC FLUORIDE - POTASSIUM FLUORIDE - WATER AT 25° (Tananaev and Deichman, 1946a)

	Gms. per 100 gms. Saturated Solution		Solid Phase	Gms. per 100 gms. Saturated Solution		Solid Phase
	KF	FeF ₃		KF	FeF ₃	
	0.52	2.30	FeF ₃ ·3H ₂ O + 2KF·FeF ₃ ·H ₂ O	3.71	.002	11KF·4FeF ₃ ·12H ₂ O
	.56	1.01	2KF·FeF ₃ ·H ₂ O	3.97	.001	"
	.62	0.24	"	4.00	.001	"
	1.37	.03	"	4.86	-	"
	1.57	.02	"	7.17	-	"
	2.40	.006	11KF·4FeF ₃ ·12H ₂ O	8.94	-	"
	2.89	.005	"	13.34	-	3KF·FeF ₃ ·3H ₂ O
	3.19	.002	"	19.80	-	"
	3.31	.002	"	22.80	-	"
	3.55	.002	"	24.07	-	"
	3.66	.002	"	31.75	-	"
				33.40	-	"

F FERRIC POTASSIUM FLUORIDE FeF₃·2KF·H₂O

The compound is congruently soluble. At 25°, one liter of a saturated solution in water contains 0.018 moles of compound. (Tananaev and Deichman, 1946a).

THE SYSTEM FERRIC FLUORIDE - SODIUM FLUORIDE - WATER AT 25°
(Tananaev and Deichman, 1945)

Gms. FeF_3 per 100 gms. Saturated Solution	Gms. NaF per 100 gms. Saturated Solution	Solid Phase
5.59	0.0	$\text{FeF}_3 \cdot 3\text{H}_2\text{O}$
7.32	0.15	$\text{FeF}_3 \cdot 3\text{H}_2\text{O} + 2\text{FeF}_3 \cdot 5\text{NaF}$
0.012	0.23	$2\text{FeF}_3 \cdot 5\text{NaF}$
Approx. 0	0.7	"

FERRIC SODIUM FLUORIDE $2\text{FeF}_3 \cdot 5\text{NaF}$

SOLUBILITY IN SODIUM SALT SOLUTIONS AT 25°
(Lel'chuk and Ruts kaya, 1949)

F

	Moles salt per liter solvent	Gms. $2\text{FeF}_3 \cdot 5\text{NaF}$ per 100 gms. sat. sol.
Na citrate ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$)	0.0 0.003 0.01 0.05 0.1 0.3 0.5 1.0	0.2551 .2513 .2869 .3984 .4488 .5040 .3912 .2216
Na salicylate ($\text{NaC}_7\text{H}_5\text{O}_3$)	0.001 0.01 0.1 1.0	0.2562 .2305 .2205 .3181
Na succinate [$(\text{CH}_2)_2(\text{CO}_2\text{Na})_2$]	0.001 0.01 0.1	0.0788 .0525 .0224
Na oxalate ($\text{Na}_2\text{C}_2\text{O}_4$)	0.001 0.1	0.2583 .6256

SOLUBILITY OF FERRIC FLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)

t°	Gms. FeF_3 per 100 gms. HF
-25.2	< 0.001
- 7.8	.003 ± .002
+11.9	.008 ± .002

Fe FERRUM

F FERROUS FLUOSILICATE FeSiF_6

THE SYSTEM $\text{FeSiF}_6 - \text{H}_2\text{O}$
(Pinaeveskaya and Radosteva, 1953)

t°	Gms. FeSiF_6 per 100 gms. sat. sol.	Solid Phase	t°	Gms. FeSiF_6 per 100 gms. sat. sol.	Solid Phase
- 1.75	10.0	Ice	10	32.50	$\text{FeSiF}_6 \cdot 6\text{H}_2\text{O}$
- 2.7	15.0	"	25	33.36	"
- 4.75	20.0	"	50	35.13	"
-14.0	30.0	Ice + $\text{FeSiF}_6 \cdot 6\text{H}_2\text{O}$	75	36.30	"
0	31.81	$\text{FeSiF}_6 \cdot 6\text{H}_2\text{O}$	105.9	39.31	"

FERRIC Hexa Antipyrine FLUOBORATE $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_3$

100 cc sat. solution of Ferric Hexa Antipyrine Borofluoride in Water contain 0.7 gm. $[\text{Fe}(\text{COC}_{10}\text{H}_{12}\text{N}_2)_6](\text{BF}_4)_3$ at 20° . (Wilke-Dorfurt and Mureck, 1929)

I FERROUS IODIDE FeI_2

THE SYSTEMS IRON - IODINE - BENZENE AND IRON - IODINE - TOLUENE AT 25°
(Foote and Fleischer, 1940)

The results indicate the non-existence of the compound FeI_3 at 6° or above.

Fe + I_2 + Toluene		Fe + I_2 + Benzene	
Gms. I_2 per 100 gms. sat. sol.	Solid Phase	Gms. I_2 per 100 gms. sat. sol.	Solid Phase
0.0	Fe + FeI_2	1.11	FeI_2
1.31	FeI_2	6.98	"
10.06	"	8.81	$\text{FeI}_2 + \text{I}_2$
10.46	$\text{FeI}_2 + \text{I}_2$		
10.30	"		

10 FERRIC IODATE $\text{Fe}(\text{IO}_3)_3$

SOLUBILITY OF THE TWO MODIFICATIONS OF FERRIC IODATE IN WATER
(v. Endrey, 1934)

t°	Gm. Mols. $\text{Fe}(\text{IO}_3)_3$ per liter sat. sol.	Solid Phase
20	6.2×10^{-4}	α Modification
20	5.7×10^{-4}	β "

FERROUS NITRATE $\text{Fe}(\text{NO}_3)_2$

NO

SOLUBILITY IN WATER
(Funk, 1900)

t°	Gms. $\text{Fe}(\text{NO}_3)_2$ per 100 Gms. Sol.	Mols. $\text{Fe}(\text{NO}_3)_2$ per 100 Mols. H_2O	Solid Phase
-27	35.66	5.54	$\text{Fe}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$
-21.5	36.10	5.64	"
-19	36.56	5.76	"
-15.5	37.17	5.91	"
-9	39.68	6.57	$\text{Fe}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
0	41.53	7.10	"
18*	45.14	8.23	"
24	46.51	8.70	"
60.5	62.50	16.67	"

*Density of solution saturated at 18° = 1.497.

FERRIC NITRATE $\text{Fe}(\text{NO}_3)_3$

NO

SOLUBILITY OF FERRIC NITRATE IN WATER
(Malquori, 1927(e)(f), 1929(a))

t°	Gms. $\text{Fe}(\text{NO}_3)_3$ per 100 gms. sat. sol.	Solid Phase
0	40.15	$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$
20	45.20*	"
25	46.57	"
40	51.18	"

*Zaslavskij and Ravdine, 1939.

THE SYSTEM FERRIC OXIDE - NITRIC ACID - WATER AT 25°
(Cameron and Robinson, 1909)

Solutions of ferric nitrate of varying concentrations were shaken with freshly precipitated ferric hydroxide at const. temp., 25°, for 4 months. The acid branch of the curve was studied in a similar manner by starting with ferric nitrate and various concentrations of nitric acid. No definite basic nitrates of iron were formed. See also the data of Malquori, below.

Fe FERRUM

THE SYSTEM FERRIC OXIDE - NITRIC ACID - WATER AT 25°--Contd.

		Gms. per 100 Gms. Sat. Sol.		
d ₂₅ of Sat. Sol.		Fe ₂ O ₃	N ₂ O ₅	Solid Phase
NO	1.032	1.78	2.21	Fe ₂ O ₃ · <u>m</u> N ₂ O ₅ · <u>n</u> H ₂ O
	1.079	3.99	5.61	"
	1.127	5.79	9.00	"
	1.177	7.22	12.31	"
	1.264	9.70	16.60	"
	1.368	12.48	22.70	"
	1.435	14.62	28.13	"
	1.498	15.40	29.52	"
	1.496	15.22	30.50	Fe ₂ O ₃ · 3N ₂ O ₅ · 18H ₂ O
	1.452	12.14	33.5	"
	1.434	9.95	36.3	"
	1.417	7.25	40.3	"
	1.404	5.02	47.5	"
	1.428	3.55	51.5	"
	1.450	4.51	52.0	"
	1.465	4.49	55.2	"
	1.407	3.93	47.2	Fe ₂ O ₃ · 4N ₂ O ₅ · 18H ₂ O*
	1.419	3.52	49.6	"

*This salt was obtained accidentally and its preparation could not be repeated.

RESULTS OF MALQUORI, 1929b AT 25°

These results supplement those of Cameron and Robinson (above) in showing that at higher concentrations of HNO₃ a lower hydrate of ferric nitrate is obtained.

Gms. per 100 gms. sat. solution

Fe(NO ₃) ₃		HNO ₃	Solid Phase
18.15		53.48	Fe(NO ₃) ₃ · 9H ₂ O
22.41		53.79	"
28.02		54.23	" + Fe(NO ₃) ₂ · 6H ₂ O
28.11		57.03	Fe(NO ₃) ₃ · 6H ₂ O

EQUILIBRIUM IN THE SYSTEM FERRIC NITRATE, POTASSIUM NITRATE AND WATER (Malquori, 1927(f), 1929(a))

Results at 0°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Fe(NO ₃) ₃	KNO ₃		Fe(NO ₃) ₃	KNO ₃	
40.15	0.0	Fe9	23.87	2.36	KNO ₃
38.68	0.94	"	21.82	2.26	"
38.55	3.92	" + KNO ₃	0.0	11.70	"

Fe9 = Fe(NO₃)₃ · 9H₂O.

(Cont.)

EQUILIBRIUM IN THE SYSTEM FERRIC NITRATE, POTASSIUM NITRATE
AND WATER--Contd..

Results at 25°

Results at 40°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Fe(NO ₃) ₃	KNO ₃		Fe(NO ₃) ₃	KNO ₃	
46.57	0.0	Fe9	51.18	0.0	Fe9
43.01	6.03	"	50.45	16.88	"
41.90	8.75	"	44.01	25.31	XNO ₃
38.11	12.92	"	45.83	21.03	"
39.95	11.02	" + KNO ₃	45.65	17.99	" NO
38.13	15.95	KNO ₃	45.15	17.04	"
39.85	10.25	"	45.10	16.81	"
40.07	6.13	"	40.17	7.75	"
37.43	3.22	"	0.0	39.00	"
21.27	5.19	"			
11.29	15.91	"			
0.0	27.31	"			

Fe9 = Fe(NO₃)₃·9H₂O

Malquori, 1929b gives results for quaternary system Fe(NO₃)₃ + HNO₃
KNO₃ + H₂O at 25°.

SOLUBILITY OF FERRIC NITRATE IN ORGANIC SOLVENTS

Solvent	t°	Solubility	Author
Ethyl ether	15	13.6 gms. Fe(NO ₃) ₃ per liter of solvent (saturating phase = Fe(NO ₃) ₃ ·9H ₂ O)	Bachelet, Cheylan and LeBris, 1950
Furfural	25	0.21 gms. Fe(NO ₃) ₃ ·6H ₂ O per 100 gms. sat. sol.	Trimble, 1941

FERROUS OXIDE FeO

FERROUS HYDROXIDE Fe(OH)₂O
OH

SOLUBILITY IN WATER

Leussing and Kolthoff (1953) summarize and evaluate the various
earlier data.

Kap	Method	Reference
3.2 x 10 ⁻¹⁴	Solubility (25°)	Whitman, Russell and Davis, 1925
9.9 x 10 ⁻¹⁵	Conductivity	Lamb, 1910
8.7 x 10 ⁻¹⁴	Solubility	Krassa, 1909
2.9 x 10 ⁻¹⁵	Conductivity (25°)	Murata, 1932
1.56 x 10 ⁻¹⁵	Solubility (25°)	
2.13 x 10 ⁻¹⁵	Colorimetric pH (25°)	
4.5 x 10 ⁻²¹	Potentiometric	Britton, 1925
4.8 x 10 ⁻¹⁶	Titration	Elder, 1930
3.9 x 10 ⁻¹⁵	pH	Shipley and McHaffie, 1924
7 x 10 ⁻¹³	Polarographic	Shrager, 1929
1.7 x 10 ⁻¹⁵	EMF	Randall and Frandsen, 1932
2.4 x 10 ⁻¹⁴	Potentiometric titration	Arden, 1950
8.8 x 10 ⁻¹⁵	Potentiometric titration	Oka, 1940
8 x 10 ⁻¹⁶	Solubility (25°)	Leussing and Kolthoff, 1953
9.6 x 10 ⁻¹⁶	Potentiometric (18°)	Aksel'rud and Fialkov, 1950

Fe FERRUM

Leussing and Kolthoff observe that Elder's data may be in error due to coprecipitation, while Murata did not attain equilibrium. Arden's high value may have been caused by supersaturation. The results of Britton, and of Shrager are clearly out of line. The solubility in water is about 1.5×10^{-5} moles per liter at 25°.

SOLUBILITY OF FERROUS HYDROXIDE IN WATER AND IN AQUEOUS SALT SOLUTIONS AT 25°

(Whitman, Russell and Davis, 1925)

OH

Solutions of ferrous hydroxide were prepared by adding pure iron powder to the deoxygenated solutions in which the solubility of ferrous hydroxide was to be determined. The solutions were allowed to stand at 40° for 18 hours and then cooled to 25°. No mention is made of constant stirring. The filtration was performed in presence of hydrogen. The dissolved iron was determined colorimetrically. The results are given in the form of charts from which the following results were read.

Normality of salt solut.	Parts of iron per million in aqueous solutions of					
	Na ₂ SO ₄	NaCl	CaCl ₂ ·6H ₂ O	CaCl ₂ (Anhy.)	NH ₄ Cl	MgCl ₂
0.0 (= H ₂ O)	3.75	3.75	3.75	3.75(9.6)	3.75(9.6)	3.75(9.6)
0.5	4.5	4.1	4.2	2.0 (9.9)	60.0 (5.2)	7.5
1.0	4.5	4.2	4.5	1.6 (10.3)	100.0 (4.9)	10.0 (5.9)
1.5	4.0	4.25	4.6	1.4	135.0	12.0
2.0	2.6	4.2	4.7	1.25(10.4)	170.0	15.0 (5.7)
2.5	-	4.15	4.8	1.05	190.0	20.0
3.0	-	4.0	-	0.95	220.0	22.0
4.0	-	3.75	-	0.75	265.0 (4.5)	25.0
4.5	-	-	-	0.70(10.5)	-	24.0 (5.4)

The figures in parentheses are the pH values of the saturated solutions.

Results are given for aqueous solutions of sodium dichromate which show that less than 0.2 part per million of iron is dissolved. The results for the solubility in aqueous sodium hydroxide and silicate solutions are expressed only in terms of pH.

The value for the solubility in water alone, namely 3.75 parts of iron per million, corresponds to 6.7×10^{-5} gms. mols. Fe(OH)₂ per liter.

One liter of aqueous 1.375 normal NaOH dissolve 7×10^{-5} gm. equiv. Fe(OH)₂ at about 20°. (Schrager, 1929)

Data are given for the following systems:

FeO + FeS	(Yazawa and Kameda, 1953)
FeO + FeS + SiO ₂	(" " " ") (Ol'ahanakii, 1950, 1950a)
FeO + Fe ₂ O ₃ + SiO ₂	(Curry and Darken, 1950)

FERRIC OXIDE Fe_2O_3

O

FERRIC HYDROXIDE $\text{Fe}(\text{OH})_3$

OH

SOLUBILITY IN WATER

Ksp:	Method	Author
3.16×10^{-38}	(18°) potentiometric	Aksel'rud and Fialkov, 1950
3.2×10^{-36}	(freshly ppt'd)	Evans and Pryor, 1949
Solubility:		
3×10^{-10}	moles per liter	Jellinek and Gordon, 1924
3.4×10^{-10}	" " "	Oka, 1940
1.4×10^{-6}	" " " in ordinary distilled water, by evaporating 2 liters of a satd. soln.	Almkvist, 1918

SOLUBILITY OF FERRIC HYDROXIDE IN AQ. OXALIC ACID SOLUTION AT 25°
(Cameron and Robinson, 1909)

The solutions were constantly agitated for 3 months. The solubility is directly proportional to the concentration of the oxalic acid and no definite basic ferric oxalate is formed.

d_{25} of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		d_{25} of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	Fe_2O_3	C_2O_3		Fe_2O_3	C_2O_3
1.007	0.48	0.61	1.040	2.33	3.10
1.015	0.95	1.23	1.050	2.98	3.85
1.031	1.86	2.45	1.064	3.62	5.17

SOLUBILITY OF $\text{Fe}(\text{OH})_3$, Fe_2O_3 AND Fe_3O_4 IN SUGAR SOLUTIONS
(Stelle, 1900)

One Liter of Sugar Solutions Dissolves Milligrams of:

% Sugar in Solvent	$\text{Fe}_2(\text{OH})_6$ at:			Fe_2O_3 at:		Fe_3O_4 at:		
	17.4°	45°	75°	17.5°	45°	17.5°	45°	75°
10	3.4	3.4	6.1	1.4	2.0	10.3	10.3	12.4
30	2.3	2.7	3.8	1.4	...	12.4	10.3	12.4
50	2.3	1.9	3.4	0.8	1.1	14.5	10.3	14.5

The reaction $\text{Fe}_2\text{O}_3 + 6\text{HCl} \rightleftharpoons 2\text{FeCl}_3 + 3\text{H}_2\text{O}$ from 300° to 1000° was investigated by Schafer, 1949a.

Fa FERRUM

PO FERROUS PHOSPHATES $x\text{FeO} \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

EQUILIBRIUM IN THE SYSTEM FERROUS OXIDE, PHOSPHORIC ACID AND WATER AT 70°
(Carter and Hartshorne, 1926)

The mixtures were prepared by dissolving Swedish iron (99.75% Fe) in solutions of phosphoric acid kept in an atmosphere of CO_2 . The mixtures were constantly stirred in a thermostat for at least a week and both the saturated solutions and solid phases were analyzed.

d_{15-20} sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	FeO	P_2O_5	
1.08	2.76 (1.2)	7.38	$2\text{FeO} \cdot \text{P}_2\text{O}_5 \cdot 5\text{H}_2\text{O}$
1.16	4.38	12.06	"
1.22	5.53	14.46	"
1.20	5.48 (1.6)	14.96	"
1.24	5.54 (5.1)	15.1	"
1.31	7.71	21.6	$2\text{FeO} \cdot \text{P}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ (cryst.)
1.39	9.18 (0.84)	25.65	"
1.43	9.88	28.25	"
1.53	10.99	32.78	"
1.60	11.25	37.20	"
1.60	11.29	37.21	"
-	9.12	24.29	$2\text{FeO} \cdot \text{P}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ (amorp.)
1.42	10.1	27.20	"
1.44	10.6	29.05	"
1.45	10.6 (0.87)	29.46	"
1.54	11.3 (0.62)	32.87	"
1.55	11.5 (0.92)	33.99	"
-	11.8	35.43	"
1.60	11.9 (2.75)	36.99	"
1.58	10.5 (0.7)	38.86	$\text{FeO} \cdot \text{P}_2\text{O}_5 \cdot 4\text{H}_2\text{O}$
1.60	8.77	41.52	"
-	7.38	42.88	"
1.61	6.29	46.61	"
1.63	4.87	50.49	"
1.63	4.01	52.02	"
1.71	3.15 (4-6)	57.51	"

The figures in parentheses show the per cent of iron present in the ferric state.

FERRIC PHOSPHATES $x\text{Fe}_2\text{O}_3 \cdot y\text{P}_2\text{O}_5 \cdot z\text{H}_2\text{O}$

PO

THE SYSTEM FERRIC OXIDE - PHOSPHOROUS PENTOXIDE - WATER
(Jameson and Salmon, 1954)

Results at 25°

Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
P ₂ O ₅	Fe ₂ O ₃	Density		P ₂ O ₅	Fe ₂ O ₃	Density	
0.350	0.003	1.00	A	61.5	1.114	-	D
1.312	0.015	1.00	"	64.0	0.919	-	"
2.32	0.033	1.00	"	66.3	0.907	-	"
3.34	0.053	1.03	"	(b) Metastable Equilibrium I: 0-23% P ₂ O ₅			
4.39	0.075	1.01	"				
4.61	0.081	1.04	"				
6.40	0.139	1.05	"				
7.90	0.212	1.05	"				
9.23	0.268	1.07	"	3.71	1.31	-	D *
11.50	0.479	1.07	"	10.08	3.11	-	" "
15.02	1.009	1.07	"	21.43	7.32	1.25	" "
17.23	1.92	1.07	"	23.09	7.67	1.26	" "
19.96	3.12	1.10	"	(c) Metastable Equilibrium II: 0-20% P ₂ O ₅			
22.13	4.20	1.15	"				
24.50	6.35	1.19	"				
26.61	7.92	1.32	B				
28.1	7.00	-	"	2.43	0.034	1.02	} †
29.9	5.72	-	"	5.60	0.202	1.07	
33.9	4.50	1.42	"	9.15	1.50	-	
37.0	4.11	-	"	14.88	3.21	-	
43.0	4.09	-	"	18.45	6.16	1.19	
45.2	4.46	1.61	"	19.06	5.93	1.20	
45.8	4.51	-	"	(d) Metastable Equilibrium III: 50-64% P ₂ O ₅			
48.1	4.78	1.70	C				
50.3	4.05	1.76	"				
51.5	3.61	-	"				
53.8	3.14	-	"				
57.3	2.62	-	"	50.1	16.32	1.62	E
59.1	1.98	-	D	55.7	10.92	-	"
60.0	1.44	1.86	"	59.8	7.19	-	"
				63.6	4.22	2.37	"

Solid Phase:

A = $\text{Fe}_2\text{O}_3 \cdot \text{P}_2\text{O}_5 \cdot 5\text{H}_2\text{O}$
 B = $\text{Fe}_2\text{O}_3 \cdot 2\text{P}_2\text{O}_5 \cdot 8\text{H}_2\text{O}$
 C = $\text{Fe}_2\text{O}_3 \cdot 3\text{P}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$

D = $\text{Fe}_2\text{O}_3 \cdot 3\text{P}_2\text{O}_5 \cdot 6\text{H}_2\text{O}$
 E = $\text{Fe}_2\text{P}_4\text{O}_{13}$

* The exact degree of hydration cannot be determined from the tie-lines.

† Not Identified.

(Cont.)

Other data at 25°
(Cameron and Bell, 1907)

Solid ferric phosphate of unknown composition was constantly agitated with aq. phosphoric acid solutions of concentrations up to 5% for 4 months. Analyses of the sat. solutions and solid phases were made and seemed to indicate the formation of solid solutions. Although no recent data indicates this, the compositions of the saturated solutions are similar to those of Jameson and Salmon, above.

	d_{25} of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
		Fe_2O_3	P_2O_5
PO	1.0074	0.0105	0.942
	1.0162	0.0205	1.984
	1.0244	0.0384	2.838
	1.0310	0.0611	3.770
	1.0383	0.0849	4.706

(Carter and Hartshorne, 1923)

Solid phase = $Fe_2O_3 \cdot P_2O_5 \cdot 5H_2O$

Gms. per 100 gms. sat. sol.

	Fe_2O_3	P_2O_5
	Trace	5.93
	0.23	10.1
	1.40	14.1
	2.43	19.8
	4.42	21.7

Results at 70°
(Carter and Hartshorne, 1923)

d_{20} of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase
	Fe_2O_3	P_2O_5	
-	trace	4.07	$Fe_2O_3 \cdot P_2O_5 \cdot xH_2O + H_3PO_5$
-	less than 0.1	6.38	$Fe_2O_3 \cdot P_2O_5 \cdot 5H_2O$
-	0.195	14.08	"
-	0.252	16.24	"
-	1.08	23.56	"
-	1.85	27.03	"
-	4.49	35.46	"
1.45	5.45	37.43	"
1.58	7.12	43.92	$Fe_2O_3 \cdot 2P_2O_5 \cdot 8H_2O$
1.65	7.25	47.87	"
1.68	7.53	49.76	"
-	8.10	52.32	"
1.82	9.79	53.2	$Fe_2O_3 \cdot 3P_2O_5 \cdot 10H_2O$
1.82	9.50	54.42	"
1.82	8.68	55.84	"
1.77	5.28	58.07	$Fe_2O_3 \cdot 3P_2O_5 \cdot 6H_2O$
-	4.42	59.12	"
-	3.46	60.47	"

The Ksp of FePO_4 is reported by Zharovskii, 1951 to be 1.3×10^{-22} at 18-20°.

Devyatyn (1940) determined the solubility of FePO_4 in H_2O , .2 N and 1.0 N K_2CO_3 solutions both cold, and at the boiling point.

The solubilities of various phosphates in the soil under varying conditions of treatment were studied by Fraps, 1911.

Ghani and Aleem (1949) shook 10 mg. of each iron phosphate with 0.5 N Acetic Acid, 0.25 N NaOH, and 2 N H_2SO_4 for 2 hours at room temperature and report the mg. of P_2O_5 dissolved in the volume of each solvent used. These figures were calculated to more convenient form below.

Solvent	FePO_4 (Normal)	$[\text{FePO}_4 \cdot 5\text{Fe}(\text{OH})_3]?$ (Basic)
	Mg. P_2O_5 per 100 ml. Solvent	
0.5 N Acetic Acid	0.12	0.095
0.25 N NaOH	0.8	0.32
2 N H_2SO_4	1.56	0.80

FERRIC PYROPHOSPHATE $\text{Fe}_4(\text{P}_2\text{O}_7)_3$

P0

SOLUBILITY FERRIC PYROPHOSPHATE IN AQ. AMMONIA AT 0° (Pascal, 1909)

The solutions containing an excess of salt were agitated violently every half hour for seven hours and filtered at 0°. The sat. sol. was analyzed for ammonia and for residue obtained by evaporation.

Gms. NH_3 per 100 Gms. Sat. Sol.	Gms. $\text{Fe}_4(\text{P}_2\text{O}_7)_3$ per 100 Gms. Sat. Sol.	Solid Phase
0.884	5.606	$\text{Fe}_4(\text{P}_2\text{O}_7)_3$
1.59	9.75	"
3.71	14.85	"
4.72	15.94	"
5.93	13.92	viscous black deposit
7.91	14.61	"
5.92	14.71	"
8.26	13.89	chamois colored lump
10.55	7.40	"
15.96	2.52	"
18.83	0.445	"

Fe FERRUM

SOLUBILITY OF FERRIC PYROPHOSPHATE IN AQUEOUS SOLUTIONS OF SODIUM PYROPHOSPHATE AND OF SODIUM CITRATE (Oliveri-Mandala, 1921)

In Aq. Sodium Pyrophosphate at 30.4°

In Aq. Sodium Citrate at 28°

Gm. mols. $\text{Na}_4\text{P}_2\text{O}_7$ per liter	Gm. mols. $\text{Fe}_4(\text{P}_2\text{O}_7)_3$ per liter		Gm. mols. per liter	
	Solid phase $\text{Fe}_4(\text{P}_2\text{O}_7)_3$	Solid phase $\text{Fe}_4(\text{P}_2\text{O}_7)_3 \cdot 9\text{H}_2\text{O}$	Na citrate	$\text{Fe}_4(\text{P}_2\text{O}_7)_3$
0.14	0.047	0.050	0.2004	0.1712
0.20	0.068	0.072	0.3951	0.3160
0.26	0.088	0.094	0.4760	0.3704
0.32	0.108	0.114	0.5289	0.4037
0.38	0.124	0.134	0.6355	0.4572

PO FERRIC SODIUM PYROPHOSPHATE $\text{Fe}_4(\text{P}_2\text{O}_7)_3 \cdot 3\text{Na}_4\text{P}_2\text{O}_7$

SOLUBILITY OF FERRIC SODIUM PYROPHOSPHATE IN AQUEOUS SOLUTIONS OF SODIUM CITRATE AND OF SODIUM CHLORIDE (Oliveri-Mandala, 1921)

In Aq. Sodium Citrate at 26°.5

Gm. mols. per liter	
Na citrate	$\text{Fe}_4(\text{P}_2\text{O}_7)_3 \cdot 3\text{Na}_4\text{P}_2\text{O}_7$
0.3456	0.0186
0.4760	0.0249
0.5374	0.0269

In Aq. Sodium Chloride at 30° and at 50°.5

Gm. mols. NaCl per liter	Gm. Mols. $\text{Fe}_4(\text{P}_2\text{O}_7)_3 \cdot 3\text{Na}_4\text{P}_2\text{O}_7$ per liter at		Gm. mols. NaCl per liter	Gm. mols. $\text{Fe}_4(\text{P}_2\text{O}_7)_3 \cdot 3\text{Na}_4\text{P}_2\text{O}_7$ per liter at	
	30°	50°.5		30°	50°.5
0.0	0.0100	0.062	0.04	0.0028	0.011
0.01	0.0077	0.039	0.05	0.0023	0.009
0.02	0.0053	0.023	0.06	0.0029	0.009
0.03	0.0037	0.015			

S FERROUS SULFIDE FeS

SOLUBILITY IN WATER

Kapustinsky (1940) calculates the K_{sp} to be 3.8×10^{-20} . Goates, Gorden and Faux (1952) find 5×10^{-18} . Weigel (1906, 1907) found the solubility to be 0.0062 gms. per liter; Mickwitz (1928) reports 0.0044

gms. per liter (both at 18°). Additional data are given by Bruner and Zawadzki (1910). A critical review of the literature is given by Kolthoff (1931).

1000 cc aq. 0.01 N H_2SO_4 sat. with H_2S dissolve 0.2136 gm. FeS at 20°. (Moser and Behr, 1924)

100 gms. anhydrous hydrazine dissolve 9 gms. FeS at room temp. with decomposition. (Welsh and Brodersen, 1915)

15 wt. % FeS dissolve in Fe_2SiO_4 at 1290° (Ol'ahanakii, 1947, 1952). Melting points in the system FeS-ZnS are given by Kullerud, 1953.

FERRIC SULFIDE Fe_2S_3

3

SOLUBILITY IN WATER

1000 cc sat. solution of ferric sulfide in water contain 3×10^{-18} gm. mol. Fe_2S_3 at room temperature determined by electrical methods. (Jellinek and Gordon, 1924)

SOLUBILITY IN AQUEOUS SUGAR SOLUTIONS (Stelle, 1900)

% Sugar in Solvent	Mg. Fe_2S_3 per liter		
	17.5°	45°	75°
10	3.8	3.8	5.3
20	7.1	9.1	7.2
50	9.9	19.8	9.1

PYRITE FeS_2

3

Isakov (1939) studied the calcination of FeS_2 at 500° and 700° in atmospheres of N_2 , H_2O , and Air and determined the solubility of the decomposition products in HCl solutions.

FERROUS SULFITE $FeSO_3$

30

EQUILIBRIUM IN THE SYSTEM FERROUS OXIDE, SULFUR DIOXIDE AND WATER AT 15° AND AT 25° (Terres and Ruhl, 1934)

The determinations were made by the synthetic method. The authors give a diagram in the present paper but the numerical results are published only in their report in Beihefte zu den Zeitschriften des Vereines deutscher Chemiker No. 8, 1934 - Verlag chemie Berlin W 35 Cornelius str. 3. Estimating from the small diagram the following approximate values were obtained.

Fe FERRUM

Results at 15°

Mol. per cent in sat. sol.		Solid Phase
FeO	SO ₂	
0.5	0.3	FeSO ₄ ·5H ₂ O(?)
1.0	0.6	"
2.0	1.2	"
2.5	1.4	" + Fe(HSO ₃) ₂ (?)
2.4	2.0	Fe(HSO ₃) ₂ (?)
2.2	3.5	"
2.3	5.0	"
2.6	7.0	"
3.0	8.1	"

Results at 25°

Mol. per cent in sat. sol.		Solid Phase
FeO	SO ₂	
0.5	0.75	FeSO ₄ ·5H ₂ O
1.0	1.3	"
1.5	1.6	"
1.9	2.0	" + Fe(HSO ₃) ₂ (?)
1.5	2.9	Fe(HSO ₃) ₂ (?)
1.25	4.0	"
1.5	5.9	"
2.0	7.6	"
2.3	8.3	"

The mixtures separated into two liquid layers at concentrations of SO₂ between 8.5 and 93 Mol. per cent.

SO FERROUS SULFATE FeSO₄

SOLUBILITY IN WATER

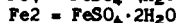
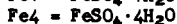
(Fraenckel, 1907; Belopolskii and Urazov, 1948; Belopolskii, Kolicheva, and Shpunt, 1948; Agde and Barkholt, 1926; Kobe and Fredrickson, 1956)

The various results are in good agreement. The values below were read from an average curve drawn through all the data. The hydrate transition temperatures were also read from the curve, and differ somewhat from the estimates of Fraenckel, and of Kobe and Fredrickson, which are given in parentheses.

Gms. FeSO ₄ per 100 gms.			Solid Phase	Gms. FeSO ₄ per 100 gms.			Solid Phase
t°	sat. sol.			t°	sat. sol.		
-0.17	1.00		Ice	56.6	35.3		FeSO ₄ ·7H ₂ O+FeSO ₄ ·4H ₂ O
-0.57	4.11		"	(56.0)	(35.4)	(K. & E.)	" + "
-1.06	8.01		"	60.5	36.7*		FeSO ₄ ·7H ₂ O+FeSO ₄ ·H ₂ O
-1.51	11.29		"	(59.0)	(37.0)*	(K. & F.)	" + "
-1.82	12.70		Ice+FeSO ₄ ·7H ₂ O	60	35.5		FeSO ₄ ·4H ₂ O
0	13.6		FeSO ₄ ·7H ₂ O	65	35.7*		"
5	15.4		"	70	35.9*		"
10	17.2		"	63.7	35.6		FeSO ₄ ·4H ₂ O+FeSO ₄ ·H ₂ O
15	19.0		"	(64.8)	...	(F.)	" + "
20	20.8		"	(61.7)	(35.7)	(K. & F.)	" + "
25	22.8		"	65	35.2		FeSO ₄ ·H ₂ O
30	24.7		"	70	33.5		"
35	26.7		"	75	32.0		"
40	28.6		"	80	30.4		"
45	30.6		"	85	28.7		"
50	32.6		"	90	27.2		"
55	34.6		"	95	25.5		"
				100	24.0?		"

*Metastable

THE SOLUBILITY OF FERROUS SULFATE IN SULFURIC ACID SOLUTIONS
(Cameron, 1930; Belopolskii and Shpunt, 1941; Belopolskii and Urusov, 1948; Belopolskii, Kolicheva and Shpunt, 1948; Bullough, 1952; Kobe and Fredrickson, 1956; Zakharchenko and Taitсорin, 1949)



Results below 0°
(Belopolskii and Urusov, 1948)

Gms. per 100 gms. sat. sol.				Gms. per 100 gms. sat. sol.				30
H ₂ SO ₄	FeSO ₄	Density	Solid Phase	H ₂ SO ₄	FeSO ₄	Density	Solid Phase	
At -20°				At -10°--Contd.				
23.30	0.0	-	I	17.34	4.77	1.177	Fe7	
22.40	1.58	-	I + Fe7	22.44	3.19	1.198	"	
23.26	1.35	-	Fe7	25.0	2.4	1.209	"	
At -15°				At -5°				
20.28	0.0	-	I	10.37	0.0	-	I	
18.37	3.53	-	I + Fe7	9.32	2.20	-	I	
22.85	2.27	-	Fe7	6.45	9.85	1.156	I + Fe7	
At -10°				8.10	9.05	1.160	Fe7	
16.30	0.0	-	I	12.51	7.44	1.173	"	
15.48	1.95	-	I	13.94	6.94	1.179	"	
13.34	6.03	1.161	I + Fe7	16.98	5.80	1.193	"	
14.30	5.72	1.164	Fe7	22.04	4.12	1.213	"	
				25.0	3.0	1.225	"	

Results at 0°

(Cameron, 1930)

(Belopolskii and Urusov, 1948)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Density
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
1.81	14.1	Fe7	Solid phase FeSO ₄ ·7H ₂ O		
4.10	13.8	"			
8.45	11.10	"	0.0	13.67	-
15.56	8.93	"	1.41	13.30	1.159
17.76	7.67	"	4.53	12.00	1.164
25.98	4.80	"	7.84	10.50	1.173
32.50	3.99	"	12.21	8.65	1.186
36.05	3.64	"	13.57	8.17	1.191
38.62	3.38	" + Fe1	16.63	6.83	1.206
41.80	2.34	Fe1	21.63	5.04	1.226
53.25	0.55	"	23.0	4.6	1.229
63.60	0.28	"			

(Cont.)

Fe FERRUM

Results at 0°--Contd.

(Kobe and Fredrickson, 1956)			(Bullough, Canning, and Strawbridge, 1952)		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
0	14.0	Fe7	0.70	13.41	Fe7
10	10.0	"	6.74	10.90	"
20	6.1	"	12.17	8.76	"
30	3.3	"	16.92	6.98	"
40.5	3.5	7 + 1	23.46	4.88	"
50	0.60	Fel	29.41	3.24	"
60	.08	"	33.40	3.02	"
70	.05	"	38.58	2.67	"
80	.06	"	41.53	2.75	"
90.3	.24	1 + Fe	42.2	2.7	7 + 1
95	.04	Fe	43.21	2.32	Fel
100	.01	"	45.83	1.51	"
			47.30	1.10	"
			53.04	0.40	"

Results from 5° to 20°

(5° - Belopol'skii and Urusov, 1948; 10°-20° Belopol'skii, Kolicheva and Shpunt, 1948)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
At 5°			At 15°		
0.0	15.45	FeSO ₄ ·7H ₂ O	0.0	19.10	FeSO ₄ ·7H ₂ O
1.35	14.75	"	3.25	17.23	"
4.36	13.58	"	3.48	17.25	"
7.59	11.92	"	6.66	15.30	"
11.90	9.87	"	7.20	15.28	"
15.21	9.38	"	10.80	13.39	"
16.22	7.92	"	11.32	13.38	"
21.22	6.10	"	15.23	11.37	"
			15.90	11.28	"
			20.75	9.28	"
			25.78	7.65	"
At 10°			At 20°		
0.0	17.12	FeSO ₄ ·7H ₂ O			
3.65	15.52	"	0.0	20.90	FeSO ₄ ·7H ₂ O
7.46	13.58	"	3.35	18.95	"
11.82	11.62	"	6.92	17.05	"
16.60	9.42	"	10.80	15.20	"
21.58	7.55	"	15.20	13.25	"
26.55	6.25	"	19.90	11.20	"
			24.75	9.50	"

(Cont.)

Results at 25°
(see also Wirth, 1912-13)

(Belopolskii, Kolicheva
and Shpunt, 1948)

(Cameron, 1930)

(Bullough, Canning and
Strawbridge, 1952)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
H ₂ SO ₄	FeSO ₄	Density	H ₂ SO ₄	FeSO ₄			H ₂ SO ₄	FeSO ₄		
Solid Phase FeSO ₄ ·7H ₂ O			1.13	22.88	Fe7		0.60	22.51	Fe7	
			3.41	20.64	"		2.92	21.05	"	
0.0	22.98	-	6.32	18.67	"		6.42	18.90	"	
3.18	20.72	-	9.37	16.79	"		16.23	14.52	"	
3.81	20.68	1.253	13.00	15.56	"		24.70	11.48	"	80
6.52	19.00	-	17.34	13.25	"		28.00	10.71	"	
7.26	18.53	1.257	24.54	11.23	"		36.65	6.91*	"	
10.30	17.15	-	27.78	10.70	Fe7 + Fe1		30.0	10.4	Fe7 + Fe1	
11.93	16.60	1.265	31.00	8.50	Fe1		21.11	12.85*	Fe1	
13.01	15.88	1.267	35.66	5.89	"		28.40	11.00*	"	
14.50	15.20	-	41.47	3.07	"		31.37	9.05	"	
15.42	14.85	1.275	45.70	1.75	"		34.45	7.05	"	
19.00	13.20	-	54.71	0.97	"		37.80	4.81	"	
20.90	12.84	-	60.23	0.56	"		42.28	2.98	"	
23.55	11.72	1.294	64.35	0.40	"		47.47	1.29	"	
27.78	10.70	-								

*metastable

Results at 27°(Kobe and Fredrickson,
1956)Results at 30°(Belopolskii, Kolicheva
and Shpunt, 1948)Results at 35°(Belopolskii, Kolicheva
and Shpunt, 1948)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Solid Phase	Gms. per 100 gms. sat. sol.			Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄			H ₂ SO ₄	FeSO ₄		
0.0	23.7	Fe·7	0.0	24.70	FeSO ₄ ·7H ₂ O		0.0	26.58	FeSO ₄ ·7H ₂ O	
10.0	17.6	"	2.77	22.93	"		2.80	24.55	"	
20.0	13.8	"	2.98	22.60	"		2.70	24.92	"	
26.6	11.8	Fe·7+Fe·1	5.86	21.15	"		5.61	23.18	"	
40.0	3.4	Fe1	6.20	21.02	"		5.83	22.95	"	
50.0	0.60	"	9.53	19.28	"		8.93	21.55	"	
60.0	0.12	"	9.70	19.25	"		9.15	21.35	"	
70.0	0.07	"	12.93	17.68	"		12.83	19.70	"	
80.0	0.12	"	13.65	17.48	"		14.73	18.98	"	
88.7	0.26	Fe·1+Fe	17.10	15.87	"		15.77	18.71	"	
95.0	0.05	Fe	18.00	15.55	"		16.85	18.00	"	
100.0	0.01	"	22.28	14.08	"		20.93	16.50	"	

Results at 40°

(Belopolskii, Kolicheva and Shpunt, 1948)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄		
0.0	28.70		8.60	23.40		FeSO ₄ ·7H ₂ O
2.63	26.55		11.95	22.06		"
5.45	24.92		15.68	20.60		"

(Cont.)

Results at 40°
(Kobe and Fredrickson, 1956)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H ₂ SO ₄	FeSO ₄	Solid Phase	H ₂ SO ₄	FeSO ₄	Solid Phase
0.0	28.7	Fe·7	50.0	0.60	Fe·1
10.0	21.9	"	60.0	0.13	"
18.2	19.5	Fe·7 + Fe·1	70.0	0.07	"
21.5	19.0	Fe·7 + Fe·4(M)*	80.0	0.13	"
25.0	15.5	Fe·4(M)*	87.3	0.26	Fe·1 + Fe
30.0	9.2	Fe·1	90.0	0.11	Fe
30	40.0	3.5	100.0	0.03	"

Results at 45°

(Belopolskii, Kolicheva & Shpunt, 1948)			(Bullough, Canning and Strawbridge, 1952)					
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
0.0	30.85	FeSO ₄ ·7H ₂ O	0.80	30.55	Fe·7	18.12	21.60	Fe·7(M)*
2.45	28.38	"	3.70	28.50	"	13.70	22.85	Fe·1
5.10	26.90	"	7.40	26.41	"	15.90	21.01	"
8.00	25.48	"	10.31	25.42	"	19.75	17.75	"
11.15	24.30	"	12.65	24.60	"	22.00	15.65	"
			15.70	22.81	"(M)*	25.75	12.65	"

Results at 50°

(Belopolskii, Kolicheva & Shpunt, 1948)			(Bullough, Canning & Strawbridge, 1952)			(Cameron, 1930)		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
7.65	28.47	Fe·7 + Fe·4	1.50	33.40	Fe·1	1.74	33.48	Fe7
8.62	27.60	Fe·4 + Fe·1	3.40	31.30	"	2.43	32.76	"
83.8	0.45	Fe·1 + Fe	4.35	30.40	"	3.87	31.91	"
			4.75	29.70	"	5.93	29.20	Fe1
			9.10	25.85	"	7.78	26.87	"
			11.05	23.90	"	11.44	24.34	"
			21.80	15.35	"	22.26	15.42	"
			30.80	8.35	"	31.30	9.25	"
			42.76	3.46	"	45.37	3.03	"
						56.49	1.01	"
						69.20	0.61	"

(M)* = metastable

(Cont.)

Results at 60°

(Kobe and Fredrickson, 1956)

(Bullough, Canning & Strawbridge, 1952)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H ₂ SO ₄	FeSO ₄	Solid Phase	H ₂ SO ₄	FeSO ₄	Solid Phase
0.0	37.5	Fe·7(m)	(1.24)	(34.5)*	Fe·4 + Fe·1
0.0	36.5	Fe·1(m)	1.35	32.30	Fe·1
0.0	35.6	Fe·4	1.97	31.70	"
9.5	27.3	Fe·4 + Fe·1	2.35	31.10	"
10.0	27.0	Fe·1	4.85	28.75	"
20.0	17.4	"	6.05	27.20	"
30.0	9.5	"	8.40	25.40	"
40.0	4.7	"	10.38	23.52	"
50.0	0.67	"	17.60	18.12	"
60.0	0.29	"	21.95	15.02	"
70.0	0.16	"	25.50	12.52	"
80.0	0.29	"	32.87	7.80	"
85.3	0.52	Fe·1 + Fe	38.96	4.56	"
95.0	0.22	Fe	46.63	1.97	"
100.0	0.10	"	54.58	0.65	"
			59.56	0.37	"
			(84.5)	(0.5)*	Fe·1 + Fe

(m) = metastable

*Belopolakii, Kolicheva and Shpunt, 1948;
Belopolakii and Urusov, 1948.

Results at 65°

(Cameron, 1930)

Results at 70°

(Belopolakii and Shpunt, 1941
Belopolakii, Kolicheva and
Shpunt, 1948)

Results at 75°

(Cameron, 1930)

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
H ₂ SO ₄	FeSO ₄	Solid Phase	H ₂ SO ₄	FeSO ₄	Solid Phase	H ₂ SO ₄	FeSO ₄	Solid Phase
1.82	34.24	Fe4	85.9	0.54	FeSO ₄ ·H ₂ O+FeSO ₄	0.43	31.46	Fe2
1.61	34.66	"				3.45	28.00	"
3.29	32.57	Fe2				5.60	25.58	"
10.21	25.11	"				8.71	22.60	"
16.32	20.48	"				10.78	21.29	"
29.46	10.38	"				21.90	14.40	"
						24.72	11.26	"
						34.72	7.05	"

(Cont.)

Results at 80°

(Bullough, Canning and Strawbridge, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
1.60	26.60	Fe·1	20.30	15.00	Fe·1
2.00	26.18	"	26.40	11.48	"
2.45	25.60	"	30.66	8.75	"
3.75	24.60	"	37.75	5.35	"
4.50	23.90	"	44.83	2.73	"
6.88	22.10	"	51.57	1.13	"
8.08	21.40	"	56.00	0.65	"
13.88	18.50	"			

Results at 90°

(Belopolskii and Shpunt, 1941; Belopolskii, Kolicheva and Shpunt, 1948)

Gms. per 100 gms. sat. sol.

H ₂ SO ₄	FeSO ₄	Solid Phase
84.13	0.82	FeSO ₄ ·H ₂ O + FeSO ₄

Results at 100°

(Kobe and Fredrickson, 1956)

(Bullough, Canning & Strawbridge, 1952)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
H ₂ SO ₄	FeSO ₄		H ₂ SO ₄	FeSO ₄	
0.0	22.5	Fe·1	2.97	18.7	Fe·1
10.0	18.0	"	5.79	17.98	"
20.0	13.6	"	8.24	17.62	"
30.0	9.2	"	11.04	17.28	"
40.0	5.2	"	13.28	16.78	"
50.0	1.8	"	16.08	15.98	"
60.0	0.66	"	19.10	14.80	"
70.0	0.38	"	21.17	14.00	"
80.0	0.42	"	28.38	9.95	"
86.8	1.06	Fe·1 + Fe	35.94	6.60	"
90.0	0.62	Fe	42.19	3.83	"
100.0	0.29	"	44.97	2.99	"
			50.85	1.62	"
			56.31	0.92	"

(Cont.)

Results above 100° of Zakharchenko and Taitaorin (1949) in 9.25% H_2SO_4

[Belopolskii and Shpunt (1950) point out that the transitions to monohydrated and anhydrous $FeSO_4$ occur below 100°, and that the solid phase could not be the heptahydrate as reported by Z. and T.]

t°	% $FeSO_4 \cdot 7H_2O$ in Sat. Sol.	% $Fe_2(SO_4)_3$ present by oxidation
100	1.10	0.01
138	1.00	0.02
163	0.84	0.03
181	0.80	0.08
232	0.48	0.18
243	0.40	0.19

Freezing-point data for mixtures of ferrous sulfate and 100 per cent sulfuric acid are given by Kendall and Davidson, 1921.

EQUILIBRIUM IN THE SYSTEM FERROUS SULFATE - FERROUS OXIDE - WATER AT 18°
(Gromov, 1948)

Gms. $FeSO_4$ per 100 gms. Sat. Sol.	Gms. Fe per liter	Density	pH	Solid Phase
19.0	88.0	1.259	6.46	$FeSO_4 \cdot 7H_2O + Fe_2O_3 \cdot 2FeO \cdot SO_3 \cdot xH_2O$
14.5	62.6	1.178	6.62	$Fe_2O_3 \cdot 2FeO \cdot SO_3 \cdot xH_2O$
9.1	36.8	1.103	6.79	"
8.5	34.5	1.100	6.80	"
4.3	16.5	1.046	6.94	"
1.55	5.8	1.015	7.14	"
0.30	1.1	1.004	8.50	"

FERROUS POTASSIUM SULFATE $FeSO_4 \cdot K_2SO_4 \cdot 6H_2O$

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SOLUBILITY IN WATER
(Tobler, 1855)

t°	Gms. $K_2Fe(SO_4)_2$ per 100 Gms. H_2O	t°	Gms. $K_2Fe(SO_4)_2$ per 100 Gms. H_2O
0	19.6	35	41
6.8	25.8*	40	45
10	24.5	55	56
14.5	29.1	65	57.3
16	30.9	70	64.2
25	36.5		

*Haber-Chuwis, 1926.

THE SYSTEM FERROUS POTASSIUM SULFATE - ZINC POTASSIUM SULFATE -
WATER AT 6.8°
(Haber-Chuwis, 1926)

d of sat. sol.	Gms. per 1000 cc sat. sol.		Mol. per cent $\text{FeK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{FeK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{ZnK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	
1.2067	329.15	0.00	100.0
1.1859	275.03	19.39	93.55
1.1758	246.80	28.82	90.08
1.1606	203.22	47.62	81.98
1.1474	173.59	53.07	76.98
1.1339	142.76	63.87	69.45
SO 1.1204	119.46	67.83	64.29
1.1085	87.69	72.46	55.30
1.0993	68.10	77.78	47.22
1.0795	0.00	113.62	0.00

THE SYSTEM FERROUS SULFATE - LITHIUM SULFATE - WATER AT 30°
(Schreinemakers, 1910)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
FeSO_4	Li_2SO_4		FeSO_4	Li_2SO_4	
24.87	0	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	15.39	16.80	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
24.45	4.00	"	12.68	18.31	"
21.15	5.58	"	5.32	22.15	"
18.79	11.16	"	3.74	23.15	"
16.51	15.81	"	0	25.1	"
16.11	16.50	" + $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$			

Data for the quaternary system $(\text{NH}_4)_2\text{SO}_4 + \text{FeSO}_4 + \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$ at 30° are given by Schreinemakers, 1910a.

THE SYSTEM FERROUS SULFATE - MANGANOUS SULFATE - WATER
(White, 1933)

Results at 0°			Results at 25°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
MnSO_4	FeSO_4		MnSO_4	FeSO_4	
3.07	12.55	$\text{Fe} \cdot 7\text{H}_2\text{O}(\text{SS})$	0.09	23.09	$\text{Fe} \cdot 7\text{H}_2\text{O}(\text{SS})$
5.83	11.44	"	3.55	21.41	"
10.66	9.26	"	6.82	18.94	"
16.52	6.84	"	10.33	16.62	"
19.18	5.69	"	13.57	14.39	"
29.30	1.25	"	24.96	7.78	"
31.28	0.34	"	36.95	1.82	"
31.84	0.14	"	37.83	1.33	" + $\text{Mn} \cdot 5\text{H}_2\text{O}(\text{SS})$
			38.29	0.85	$\text{Mn} \cdot 5\text{H}_2\text{O}(\text{SS})$
			39.39	0.33	"

$\text{Fe} \cdot 7\text{H}_2\text{O}(\text{SS}) = \text{FeSO}_4$ Heptahydrate Solid Solution; $\text{Mn} \cdot 5\text{H}_2\text{O}(\text{SS}) = \text{MnSO}_4$ Penta-hydrate Solid Solution.

THE SYSTEM FERROUS SULFATE - AMMONIUM SULFATE - WATER AT 30°
(Schreinemakers, 1910a)

Gms. per 100 Gms. Sat. Solution			Gms. per 100 Gms. Sat. Solution		
$(\text{NH}_4)_2\text{SO}_4$	FeSO_4	Solid Phase	$(\text{NH}_4)_2\text{SO}_4$	FeSO_4	Solid Phase
44.27	0	$(\text{NH}_4)_2\text{SO}_4$	8.90	17.64	1.1.6
43.88	0.79	$(\text{NH}_4)_2\text{SO}_4 + 1.1.6$	6.44	23.59	"
34.24	1.72	1.1.6	5.91	25.24	1.1.6 + $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
19.64	5.70	"	5.24	25.24	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
16.29	7.95	"	0	24.90	"
11.45	13.13*	"			

1.1.6 = $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$

*Solubility of double salt in water.

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FERROUS AMMONIUM SULFATE $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$

SOLUBILITY IN WATER
(Tobler, 1855)

t°	Gms. $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$ per 100 gms. sat. sol.	t°	Gms. $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$ per 100 gms. sat. sol.
0	11.1	25	20.0
7	17.60 ^a		20.3 ^c
8.5	18.00 ^a	30	24.58 ^d
15	16.7	40	24.8
20	20.90 ^b	50	28.6
		70	34.2

^aOstersetzer, 1926^cLocke, 1902^bGorshstein and Silanteva, 1954^dSchreinemakers, 1910a

THE SYSTEM FERROUS AMMONIUM SULFATE - NICKEL AMMONIUM SULFATE - WATER
(Gorshstein and Silanteva, 1954)

Ni = $\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ Fe = $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$

(Solid phase = continuous hexahydrated solid solutions)

Results at 0°

Wet Residue Wt. %		Sat. Sol. Wt. %		Wet Residue Wt. %		Sat. Sol. Wt. %	
Ni	Fe	Ni	Fe	Ni	Fe	Ni	Fe
15.39	71.58	0.30	18.00	82.24	11.66	2.94	4.33
26.07	67.53	0.57	16.53	84.29	10.11	3.31	3.34
32.78	57.41	0.73	13.91	87.59	7.23	3.25	2.54
55.20	40.21	1.19	-10.90	87.20	4.44	4.36	1.65

(Cont.)

THE SYSTEM FERROUS AMMONIUM SULFATE - NICKEL AMMONIUM
SULFATE - WATER--Contd.

Results at 20°

Wet Residue Wt. %	Sat. Sol. Wt. %	Wet Residue Wt. %	Sat. Sol. Wt. %
Ni	Fe	Ni	Fe
-	-	0.0	28.75
10.54	83.80	0.26	26.70
19.90	76.79	0.54	24.79
30.40	66.47	0.86	22.61
49.50	43.92	1.68	17.50
60.74	34.05	2.13	14.70
74.17	20.68	3.66	9.76
76.63	18.26	3.70	8.96

THE SYSTEM FERROUS AMMONIUM SULFATE - ZINC AMMONIUM SULFATE - WATER
(Oeteraetzer, 1926)

Results at 7°

d of sat. sol.	Gms. per 1000 cc sat. sol.		Wt. per cent $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ in Solid Phase
	$\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	$\text{Zn}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	
1.1541	279.49	0.00	100.0
1.1454	236.84	18.99	85.17
1.1392	220.24	22.47	76.57
1.1377	181.49	40.10	59.99
1.1203	158.60	46.88	49.52
1.1115	125.20	62.89	37.74
1.1051	101.64	70.93	29.51
1.0965	73.58	82.46	18.19
1.0912	54.36	92.10	13.18
1.0794	0.00	125.50	0.00

Results at 8.5°

1.1578	286.52	0.00	100.0
1.1452	243.71	24.00	87.12
1.1366	212.66	34.99	71.40
1.1304	183.13	45.93	56.76
1.1184	157.54	54.60	49.51
1.1121	133.70	63.35	38.42
1.1035	103.70	72.95	27.46
1.0963	78.82	81.59	18.63
1.0891	53.45	95.04	11.56
1.0875	27.65	112.25	5.78
1.0798	0.00	128.30	0.00

THE SYSTEM FERROUS SULFATE - SODIUM SULFATE - WATER

Results of Koppel, 1905 at several temperatures

Gms. per 100 Gms.
Sat. Solution

t°	FeSO ₄	Na ₂ SO ₄	Solid Phase	
0	14.54	4.93	FeSO ₄ ·7H ₂ O + Na ₂ SO ₄ ·10H ₂ O	
15.5	17.76	11.32	" + "	
21.8	16.57	15.32	FeNa ₂ (SO ₄) ₂ ·4H ₂ O	
24.92	16.21	15.13	"	
35	16.35	14.98	"	30
40	16.37	15.42	"	
18.8	18.13	13.8	FeNa ₂ (SO ₄) ₂ ·4H ₂ O + FeSO ₄ ·7H ₂ O	
23	19.58	12.5	"	
27	20.97	11.3	"	
31	22.91	9.71	"	
35	23.85	9.26	"	
40	26.32	7.85	"	
18.8	18.23	14.83	FeNa ₂ (SO ₄) ₂ ·4H ₂ O + Na ₂ SO ₄ ·10H ₂ O	
23	13.83	18.04	"	
28	7.66	24.41	"	
31	4.58	29.50	"	
35	4.04	30.49	FeNa ₂ (SO ₄) ₂ ·4H ₂ O + Na ₂ SO ₄	
40	4.10	30.60	"	

Results of Benrath and Benrath, 1929 at 97°

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Na ₂ SO ₄	FeSO ₄	Solid Phase	Na ₂ SO ₄	FeSO ₄	Solid Phase
0.0	19.57	FeSO ₄ ·H ₂ O	23.30	6.68	1.1.2
1.92	18.47	"	24.91	6.51	" + 1.3
5.69	16.12	"	25.99	4.93	1.3
14.15	11.50	"	27.17	3.94	"
16.60	10.48	"	28.81	2.32	"
19.22	11.20	" + 1.1.2	28.11	2.35	" + Na ₂ SO ₄
19.72	10.33	1.1.2	29.09	1.46	Na ₂ SO ₄
22.87	7.32	"	30.50	0.0	"

THE SYSTEM FERROUS SULFATE - NICKEL SULFATE - WATER AT 20°

(Gorshtein and Silanteva, 1953)

Fe = FeSO₄·7H₂O; Ni = NiSO₄·7H₂O; Solid phase = heptahydrated solid solutions

Wet Residue Wt. %		Sat. Sol. Wt. %		Wet Residue Wt. %		Sat. Sol. Wt. %	
Fe	Ni	Fe	Ni	Fe	Ni	Fe	Ni
-	-	-	49.24	49.28	44.70	16.75	34.69
1.20	95.00	1.29	47.85	52.29	39.49	18.61	29.72
2.32	91.86	2.34	46.48	61.38	32.39	21.18	27.23
5.45	86.47	5.13	43.82	75.01	18.42	27.70	16.41
5.17	85.03	4.87	44.95	82.58	10.09	31.78	9.24
10.03	85.91	9.08	42.69	89.59	4.99	34.94	4.50
18.34	77.55	16.27	36.40	91.05	2.75	36.40	2.46
				-	-	37.05	-

Data for the distribution of FeSO_4 between butyl alcohol and water ($K_{\text{alc.}/\text{H}_2\text{O}} \approx 0.0001$) and in the presence of H_2SO_4 , Na_2SO_4 and $(\text{NH}_4)_2\text{SO}_4$ at 25° are reported by Schlea, 1955.

100 grams sat. solution in glycol contain 6 gms. FeSO_4 at ordinary temperature. (de Coninck)

100 gms. anhydrous hydrazine dissolve 1 gm. ferrous sulfate at room temp. with decomposition. (Welsh and Broderson, 1915)

50 FERRIC SULFATE $\text{Fe}_2(\text{SO}_4)_3$

THE SYSTEM FERRIC OXIDE - SULFUR TRIOXIDE - WATER

The various results are in general agreement, but differ in detail. At 25° , up to 26-30% SO_3 , the saturating phase is a solid solution. In the range between 26-30% and 31-32% SO_3 , the 1:3 compound ($\text{Fe}_2(\text{SO}_4)_3$) (and possibly a $1:2\frac{1}{2}$ compound) is stable. This is variously reported as having 7, 9 or 10 molecules of water. Above 32% SO_3 the 1:4 acid salt ($\text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4$) exists with 9 or 10 moles of water of hydration.

Results of Baskerville and Cameron, 1935 at 25°

Many series of determinations were made upon mixtures prepared in different ways and agitated for various lengths of time (for periods of as long as a year). The limiting members of the solid solutions appeared to be ferric oxide on the one hand and on the other a compound approaching the composition $\text{Fe}_2\text{O}_3 \cdot 2.5\text{SO}_3 \cdot 7\text{H}_2\text{O}$.

d. of sat. sol.	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	Fe_2O_3	SO_3		Fe_2O_3	SO_3		Fe_2O_3	SO_3	
1.052	2.45	3.55	SS	15.10	29.14	$1 \cdot 2\frac{1}{2} \cdot 7$	6.96	32.06	1.4.9
1.104	4.86	2.83	"	15.94	28.88	"	4.70	32.08	"
1.229	9.86	12.55	"	16.70	28.00	"	2.03	34.33	"
1.242	10.19	12.98	"	17.31	27.45	"	0.26	38.72	"
1.328	12.33	18.17	"	18.21	26.85	"	0.03	56.79	"
1.397	15.52	19.21	"	19.06	26.77	"	8.4	31.8*	" + 1.3.8
1.500	17.19	23.96	"	16.4	28.2	" + 1.3.9	10.34	30.96	1.3.8
1.471	16.67	24.67	"	14.49	28.28	1.3.9	8.94	31.54	"
1.550	19.08	25.22	"	12.18	28.88	"	14.7	30.3*	" + 1.2.7
1.590	17.95	28.95	"	11.06	28.92	"	8.11	31.88	1.4.9
-	20.5	26.4	" + 1.2.7	9.31	29.64	"	7.96	31.86	"
				7.2	32.1	" + 1.4.9			

*Metastable

$1 \cdot 2\frac{1}{2} \cdot 7 = \text{Fe}_2\text{O}_3 \cdot 2.5\text{SO}_3 \cdot 7\text{H}_2\text{O}$; $1 \cdot 3 \cdot 9 = \text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 9\text{H}_2\text{O}$; $1 \cdot 4 \cdot 9 = \text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$;
 $1 \cdot 3 \cdot 8 = \text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 8\text{H}_2\text{O}$; SS = Solid Solution.

THE SYSTEM $\text{Fe}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ --Contd.

Results of Cameron and Robinson, 1907 at 25°

(Excess of freshly precipitated ferric hydroxide was added to ferric sulfate solutions of varying concentrations and the mixtures constantly shaken for 4 months.)

d_{25}° of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	Fe_2O_3	SO_3		Fe_2O_3	SO_3	
1.001	0.07	0.11	Solid Solution	20.48	26.18	$\text{Fe}_2\text{O}_3 \cdot \text{SO}_3 \cdot 10\text{H}_2\text{O}$
1.011	0.62	0.94	"	19.77	28.93	"
1.045	2.03	2.65	"	10.87	31.35	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 10\text{H}_2\text{O}$
1.131	6.18	7.40	"	0.16	35.96	"
1.217	10.03	11.84	"	0.07	41.19	"
1.440	15.90	20.70	"	1.05	42.43	"

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Results of Appleby and Wilkes, 1922

Results at 18°

Results at 25°

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Fe_2O_3	SO_3		Fe_2O_3	SO_3	
0.21	40.64	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$	0.27	39.77	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$
0.91	36.45	"	0.71	37.22	"
6.48	32.43	"	2.38	34.99	"
8.00	31.85	"	3.88	33.20	"
9.63	31.88	" + $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$	8.04	32.06	$\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$
11.69	30.80	$\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$	10.55	30.77	"
13.88	29.71	"	13.80	30.02	"
17.48	29.73	"	17.52	29.85	$5(\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3) \cdot 2\text{Fe}_2\text{O}_3$
18.68	29.64	" + Basic solid solut.	18.56	29.98	"
17.96	25.42	Basic solid solutions	19.98	29.19	Basic solid solutions
14.00	17.71	"	19.78	27.90	"
11.60	13.85	"	19.55	25.99	"
6.81	7.60	"	15.53	17.62	"
			13.51	14.58	"
			7.91	8.19	"

Results of Wirth and Bakke, 1914 at 25°

(The mixtures were shaken for 3-4 weeks)

Gms. per 100 Gms. Sat. Sol.		Solid Phase
Fe_2O_3	SO_3	
...	71.23	not det.
0.24	56.84	"
3.53	34	prob. $\text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 9\text{H}_2\text{O} + \text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$
6.65	32.15	$\text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$
9.39	31.54	" + $\text{Fe}(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$

THE SYSTEM $\text{Fe}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ --Contd.

Results of Wirth and Bakke, 1914 at 25°--Contd.

Gms. per 100 Gms. Sat. Sol.		Solid Phase
Fe_2O_3	SO_3	
12.03	31.51	$\text{Fe}(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$
13.27	31.84	"
13.68	31.78	unstable
14.49	31.45	"
15.71	31.88	"
SO 20.21	31.30	"
9.39	31.54	$\text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O} + \text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
11.06	29.43	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
13.88	28.33	"
15.23	27.92	"
16.07	27.98	"

Results are also given for the two forms of yellow ferric sulfate (α copiapite and β copiapite) also for ferric hydroxide and sulfate solutions.

SOLUBILITY OF FERRIC SULFATE IN SOLUTIONS OF SULFURIC ACID AT 25°
(Wirth, 1912-13)

Normality of acid used	2.25	6.685	19.84
Gms. $\text{Fe}_2(\text{SO}_4)_3$ per 100 gms. sat. sol.	25.02	14.58	0.05

Results of Koerker and Calderwood, 1938 at 10° and 15°

Weighed samples were agitated in sealed glass bottles for various lengths of time and allowed to settle. The liquid and solid were separated by filtration using a fritted glass filter. This required considerable time and the operation was conducted in the constant temperature bath. Both the filtrates and the moist solids were analyzed.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
Fe_2O_3	SO_3		Fe_2O_3	SO_3	
Results at 10°					
2.76	4.12	SS	0.0	37.23	SS
7.32	12.59	"	0.4	45.00	"
16.30	25.88	"	0.27	48.40	"
2.23	16.19	$\text{Fe}_2\text{O}_3 + 2.44\text{SO}_3 + 8.65\text{H}_2\text{O}$	0.41	50.10	"
6.70	31.27	"	0.04	74.50	"

SS = Solid Solution

(Cont.)

THE SYSTEM $\text{Fe}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ —Contd.

Results of Koerker and Calderwood, 1938 at 15°

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
Fe_2O_3	SO_3	Solid Phase	Fe_2O_3	SO_3	Solid Phase
12.46	16.60	SS	0.01	37.20	$\text{Fe}_2\text{O}_3 \cdot 4.46\text{SO}_3 \cdot 192\text{H}_2\text{O}$
14.61	21.23	"	3.59	30.60	$\text{Fe}_2\text{O}_3 \cdot 5.84\text{SO}_3 \cdot 30\text{H}_2\text{O}$
15.70	23.05	"	0.77	34.80	"
16.63	24.00	"	0.01	37.20	"
17.61	26.45	"	7.02	29.39*	"
16.10	25.40	$\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 18\text{H}_2\text{O}$	0.98	30.32*	"
15.86	24.98	"	13.18	32.84	$\text{Fe}_2\text{O}_3 \cdot 3 \cdot 3\text{SO}_3 \cdot 10 \cdot 3\text{H}_2\text{O}$
14.47	26.15	"	10.04	33.21	"
14.20	28.25	"	2.48	35.23	"
17.11	31.01*	"	0.80	36.40	"
18.75	31.94*	"	0.01	9.33	"
17.57	31.85*	"	14.09	33.80*	"
10.30	30.90	$\text{Fe}_2\text{O}_3 \cdot 4.46\text{SO}_3 \cdot 192\text{H}_2\text{O}$	15.65	42.27*	"
7.25	32.31	"			
2.48	35.23	"			
0.80	36.40	"			

*Supersaturated
SS = Solid Solution

Results of Posnjak and Merwin, 1922 from 50° to 200°

The authors give a critical discussion of previous work on this system. Their own determinations were made with the greatest possible accuracy. The identification of the solid phases was made both microscopically and analytically. Sealed tubes were used and at temperatures above 50° the tubes were heated by means of a resistance furnace within a steel bomb. The time required for equilibrium varied from 2 months at 50° to only a week or 10 days at the higher temperatures.

Similar data for the 75°, 110°, 140° and 200° isotherms are given and also several determinations at 130°, 150° and 300°.

Results for the Isotherm at 50°

Gms. per 100 gms. sat. sol.		Solid Phase
Fe_2O_3	SO_3	
0.01	0.10*	$\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$
0.14	0.39	"
0.39	0.79	"
0.90	1.53	"
1.44	2.30	" + $3\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 3\text{H}_2\text{O} (?)$
(1.95)	(2.94)*	" + "
(2.54)	(3.57)*	" + "
2.55	4.08	$3\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$

*Tunell and Posnjak, 1931.

(Cont.)

THE SYSTEM $\text{Fe}_2\text{O}_3 - \text{SO}_3 - \text{H}_2\text{O}$ —Contd.Results for the Isotherm at 50° —Contd.

Gms. per 100 gms. sat. sol.		Solid Phase
Fe_2O_3	SO_3	
5.71	9.09	$3\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$
7.19	11.19	"
15.43	20.08	"
16.09	20.81	"
17.96	22.96	" + $\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 5\text{H}_2\text{O}$
20.13	27.18	$\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 5\text{H}_2\text{O}$
20.70	28.40	$2\text{Fe}_2\text{O}_3 \cdot 5\text{SO}_3 \cdot 17\text{H}_2\text{O}$
16.78	30.72	" + $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$
10.26	31.91	$\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$
8.56	32.52	"
5.55	33.96	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$
0.34	41.18	"
0.10	48.44	"
0.09	55.34	"
0.07	59.20	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 3\text{H}_2\text{O}$
0.08	62.34	"
0.07	75.37	"

Results of Zakharchenko and Tsitsorin, 1949 in 9.25% H_2SO_4

t°	100	138	163	181	232	243
$\text{Fe}_2(\text{SO}_4)_3$ in sat. sol.	0.10	0.11	0.11	0.13	0.18	0.23

THE SYSTEM FERRIC SULFATE - FERRIC OXIDE - WATER AT 18°
(Gromov, 1948)

Gms. H_2SO_4 per liter	Gms. Fe per liter	pH	Solid Phase
42.8	19.9	0.68	$3\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot x\text{H}_2\text{O}$
26.0	11.3	0.98	"
24.3	10.4	1.01	"
22.4	9.7	1.05	"
18.3	8.7	1.14	"
14.6	6.1	1.24	"
10.0	4.3	1.40	"
8.0	3.2	1.49	"
3.3	1.14	1.88	"
1.9	0.40	2.12	"
0.25	0.07	2.59	"
Trace	Trace	4.14	$2\text{Fe}_2\text{O}_3 \cdot \text{SO}_3 \cdot x\text{H}_2\text{O}$

THE SYSTEM FERRIC SULFATE - FERROUS SULFATE - WATER
(Cameron, 1936)

The mixtures were agitated for seven months.

Results at 25°

Gms. per 100 gms. sat. sol.

FeSO ₄	Fe ₂ (SO ₄) ₃	Excess SO ₄	Solid Phase,
0.38	44.75	1.48	B.F.S.
0.82	44.15	1.93	" SO
1.36	43.79	3.19	"
2.01	43.32	2.98	"
2.61	43.25	1.12	"
3.07	42.60	1.56	" + FeSO ₄ ·7H ₂ O
5.30	38.42	3.61	" "
8.16	36.60	1.90	Fe ₂ (SO ₄) ₃ + "
10.47	28.36	0.25	" "
15.23	16.64	0.04	" "
20.24	5.73	0.21	" "
22.50	1.36	0.63	" "

Results at 50°

0.19	48.73	0.78	B.F.S.
0.67	46.54	2.59	"
3.67	44.50	1.33	"
6.18	41.03	3.16	" + FeSO ₄ ·7H ₂ O
8.02	38.87	5.20	" "
10.55	36.61	2.50	" "
14.74	32.94	1.09	FeSO ₄ ·7H ₂ O
19.40	25.35	0.95	"
21.76	19.85	1.01	"
27.88	9.67	0.22	"
30.35	5.40	0.30	"
31.99	2.79	0.67	"

B.F.S. = Basic Ferric Sulfate, at concentrations of FeSO₄ less than 8.16 per cent at 25° and 14.74 per cent at 50° the nature of the solid phase is uncertain.

Fe FERRUM

THE SYSTEM FERRIC SULFATE - POTASSIUM SULFATE - WATER AT 25°
(Cameron, 1936)

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	K_2SO_4	$Fe_2(SO_4)_3$		K_2SO_4	$Fe_2(SO_4)_3$	
	2.83	27.8	1.2·14	11.7	0.85	1.2·14 + K_2SO_4
	2.94	24.3	"	12.2	1.25*	"
	3.34	21.8	"	12.5	1.53*	"
	3.38	20.8	"	13.1	1.68*	"
	4.56	13.1	"	13.7	1.88*	"
	5.43	11.2	"	11.9	0.69	K_2SO_4
SO	5.32	9.02	"	11.8	0.31	"
	6.21	6.04	"	11.5	0.10	"
	8.0	2.35	"	11.3	0.02	"

*Probably points on a boundary curve of a four component system.



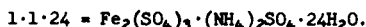
The solutions contained a variable small excess of SO_4 .

Data for the system $Fe_2O_3 - SO_3 - K_2O - H_2O$ at 25° are given by Ryazanov, 1954. The basic salt $Fe_2(SO_4)_3 \cdot 2.5Fe(OH)_3 \cdot 0.75K_2SO_4$ was found in the region investigated.

THE SYSTEM FERRIC SULFATE - AMMONIUM SULFATE - WATER AT 25°
(Cameron, 1936)

The solutions contained a variable small excess of SO_4 .

	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	$(NH_4)_2SO_4$	$Fe_2(SO_4)_3$		$(NH_4)_2SO_4$	$Fe_2(SO_4)_3$	
	1.4	44.5	?	11.7	20.6	1.1·24
	1.5	44.2	?	14.8	18.0	"
	1.7	44.4	1.1·24 + ?	17.3	16.3	" + $(NH_4)_2SO_4$
	1.9	43.1	1.1·24	26.6	9.0	$(NH_4)_2SO_4$
	2.2	39.2	"	40.8	1.4	"
	3.3	32.8	"	44 ?	0.5	"
	4.8	28.7	"			



SO FERRIC AMMONIUM SULFATE $Fe_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O$

SOLUBILITY IN WATER AT 25°

100 cc H_2O dissolve 44.15 gms. anhydrous or 124.40 gms. hydrated salt. (Locke, 1901)

100 gms. sat. sol. contain 32.6 gms. of anhydrous double salt. (Cameron, 1936)

Sp. gr. of saturated solution at 15° = 1.203. (Locke, 1901)

Data for part of the quaternary system $\text{Fe}_2\text{O}_3 - (\text{NH}_4)_2\text{O} - \text{SO}_3 - \text{H}_2\text{O}$ ($\text{Fe}_2(\text{SO}_4)_3 - (\text{NH}_4)_2\text{SO}_4 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$) are given by Shishkin (1951) and Shishkin and Krogus (1950). Solid solutions are formed between the various ferric ammonium sulfates.

Data for the extraction of Fe(III) from aqueous $\text{H}_2\text{SO}_4 - \text{Na}_2\text{SO}_4$ solutions at 25° by dodecylamine sulfate + benzene are given by Baes, 1955.

SOLUBILITY OF FERRIC SULFATE IN ALCOHOL (Wirth and Bakke, 1914)

It was found that a saturated solution of $\text{Fe}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$ in abs. alcohol at 25° contained 8 gms. Fe_2O_3 + 17.18 gms. SO_3 (Ratio, 1:4.235) per 100 gms. sat. sol.

The yellow ferric sulfate $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ is less soluble in alcohol. After 4 weeks shaking at 25° , 100 gms. of the sat. solution in abs. alcohol contained 4.497 gms. Fe_2O_3 and 6.779 gms. SO_3 (Ratio, 1:3.006). Thus the alcoholic solution, just as the aqueous, is considerably more acid than the solid phase with which it is in equilibrium.

SOLUBILITY OF $\text{Fe}_2(\text{SO}_4)_3$ IN SULFUR CHLORIDES

The solubility of $\text{Fe}_2(\text{SO}_4)_3$ in pure S_2Cl_2 and SCl_2 at $20^\circ - 30^\circ$ is less than 1 mg. %, and at $60^\circ - 100^\circ$, less than 2 mg. %. In a mixture of the solvents the solubility is slightly greater than in either alone. - Ionescu and Piatkowski, 1939.

GALLIUM Ga

MUTUAL SOLUBILITY OF GALLIUM AND MERCURY (Spicer and Bartholomay, 1951)

t°	Wt. % Gallium	
	Gallium-rich layer	Mercury-rich layer
35	93.5	1.3
100	91.4	1.4

SOLUBILITY OF GALLIUM IN LIQUID YELLOW PHOSPHORUS (Armstrong and Rotarin, 1954)

At 45° between 0.01 and 0.1 gm. Ga dissolve in 1 ml. yellow phosphorus (P_4).

The phase diagram of the system Ga-I indicates the formation of three iodides GaI , GaI_2 and GaI_3 . (Corbett and McMillan, 1955)

The solubility of Gallium in copper and silver was determined by Owen and Rowlands (1940) by means of X-Rays.

Ga GALLIUM

CH GALLIUM LACTATE $\text{Ga}(\text{CH}_3\text{CHOHCOO})_3$

SOLUBILITY IN VARIOUS SOLVENTS (Dudley and Garzón, 1948)

Solvent	t°	Gms. $\text{Ga}(\text{CH}_3\text{CHOHCOO})_3$ per 100 ml. Solution
Water	20	8.9
"	100	21.5
95% Ethyl Alcohol	20	1.5
Ether (Anhydrous)	20	0.015
Acetone (Anhydrous)	20	0.004

GALLIUM OXINE $\text{Ga}(\text{C}_7\text{H}_6\text{NO})_3$ (8-hydroxy quinolate)

The solubility product in water is 1.6×10^{-41} (room temperature) and at 18°, 0.092 moles are dissolved in one liter of a saturated solution in chloroform. (LaCroix, 1947) (Dyrssen and Dehlberg, 1953)

Data for the gallium chelate of 5 chloro-7iodo-8quinolinol are given by Recktenwald, 1955.

CN GALLIUM FERROCYANIDE $\text{Ga}_4(\text{Fe}(\text{CN})_6)_3$

A saturated solution in water contains 6.0×10^{-3} gm. ions Ga^{+++} per liter. (Tananaev, Glushkova and Seifer, 1956)

Cl GALLIUM CHLORIDE GaCl_3

More than 130 gms. GaCl_3 will dissolve in 1000 gms. of a saturated solution of HCl in water at room temperature. (Gastinger, 1954)

Data for the distribution of GaCl_3 between water solutions and isopropyl ether are given by Swift, 1924; Grahame and Seaborg, 1938; and Nachtrieb and Fryxell, 1949. At high gallium concentrations extraction into the ether layer is favored.

The phase diagrams of the systems $\text{GaCl}_3 + \text{CH}_3\text{Cl}$, $\text{GaCl}_3 + \text{CH}_3\text{Br}$, and $\text{GaCl}_3 + \text{CH}_3\text{I}$ (below 0°) were determined by vapor pressure measurements by Brown, Eddy and Wong, 1953.

GALLIUM FLUORIDE GaF₃

F

THE SYSTEM GaF₃ - NaF - H₂O AT 25°
(Tananaev and Bauaova, 1955)

Moles per liter sat. sol.		Solid Phase	Moles per liter eat. sol.		Solid Phase
NaF	GaF ₃		NaF	GaF ₃	
0.0422	0.0214	13NaF·5GaF ₃	0.0957	Trace	13NaF·5GaF ₃
.0245	.0126	"	.1189	"	"
.0429	.0056	"	.1620	"	"
.0496	.0009	"	.2695	"	"
.0753	.000006	"	.3678	"	"

The authors also state that the solubility of GaF₃·3H₂O in water at 25° is "4.1%" (?).

GALLIUM HYDROXIDE Ga(OH)₃

OH

SOLUBILITY IN WATER

t°	Moles per liter	Kap	Author
10	4.2 x 10 ⁻¹⁰	1.0 x 10 ⁻³⁶	{ Moeller and King, 1950 }
25	7.1 x 10 ⁻¹⁰	7.0 x 10 ⁻³⁶	
40	13.4 x 10 ⁻¹⁰	9.4 x 10 ⁻³⁵	
Room	6 x 10 ⁻¹⁰	-	{ Oka, 1940 }

SOLUBILITY OF GALLIUM HYDROXIDE IN AQUEOUS SOLUTIONS
OF SODIUM HYDROXIDE AT 18-26°
(Fricke and Blencke, 1925)

Normality of aq. NaOH	Gms. Ga ₂ O ₃ per 100 cc sat. sol.	Normality of aq. NaOH	Gms. Ga ₂ O ₃ per 100 cc sat. sol.
1.39	0.77	11.01	7.12
3.65	2.01	11.49	5.98
7.57	4.24	12.68	4.28
9.61	7.01	12.75	4.65
10.34	9.02	15.24	2.94
10.37	8.83	15.37	2.26

Delapine (1953) determined the solubility of gallium hydroxide in ammonia solutions by adding gallium ammonium alum or gallium potassium alum to ammonia solutions. The results are somewhat erratic, but show about 8 moles NH₃ needed to keep 1 mole Ga(OH)₃ in solution. Approximate values:

N NH ₃	:	0.05	0.08	0.2	0.3
Gms. Ga ₂ O ₃ per liter:		0.6	1.0	2.0	3.7

Gd GADOLINIUM

GALLIUM AMMONIUM SULFATE (ALUM) $\text{GaNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$

SO

(Data of Dennis and Bridgman, 1918 at 25°)

Solvent	Solubility				
Water	30.84	gms.	$\text{GaNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	per 100 cc	sat. sol.
50% $\text{C}_2\text{H}_5\text{OH}$	0.0217	"	"	"	"
70% $\text{C}_2\text{H}_5\text{OH}$	0.00875	"	"	"	"
Mixt. of					
35 cc H_2O +	0.1613	"	"	"	"
50 cc $\text{C}_2\text{H}_5\text{OH}$ +					
15 cc conc. H_2SO_4					

GALLIUM SELENATE $\text{Ga}_2(\text{SeO}_4)_3 \cdot 23\text{H}_2\text{O}$

SeO

An excess of air dried gallium selenate was added to water and the mixture kept at 25° for 6 hours. Constant shaking is not mentioned. Samples of the clear supernatant solution were weighed and their content of gallium determined by the sodium sulfite method. 100 gms. of the saturated solution contained 12.05 gms. Ga_2O_3 at 25°. (Dennis and Bridgman, 1918)

GADOLINIUM

BrO GADOLINIUM BROMATE $\text{Gd}(\text{BrO}_3)_3$

SOLUBILITY OF GADOLINIUM BROMATE IN WATER
(James, Fogg, McIntire, Evans and Donovan, 1927)

Gms.			Gms.		
$\text{Gd}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$	Solid		$\text{Gd}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$	Solid	
t° per 100 gms. H_2O	Phase		t° per 100 gms. H_2O	Phase	
0	50.18	$\text{Gd}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$	25	110.5	$\text{Gd}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$
5	60.01	"	30	126.1	"
10	70.11	"	35	144.5	"
15	82.64	"	40	166.0	"
20	95.58	"	45	195.6	"

CH GADOLINIUM ACETATE $\text{Gd}(\text{CH}_3\text{COO})_3 \cdot 4\text{H}_2\text{O}$

100 gms. sat. sol. of gadolinium acetate in water contain 10.37 gm. $\text{Gd}(\text{CH}_3\text{COO})_3$ at 25°. (Meyer and Muller, 1920)

GADOLINIUM LACTATE $\text{Gd}(\text{C}_3\text{H}_5\text{O}_3)_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$

100 gms. sat. sol. of gadolinium lactate in water contain 0.154 gms. Gd_2O_3 , equivalent to 3.833 gms. $\text{Gd}(\text{C}_3\text{H}_5\text{O}_3)_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$, at 20°. (Jantsch, 1926)

GADOLINIUM GLYCOLATE $Gd_2(C_2H_3O_3)_3 \cdot 2H_2O$

CH

1000 cc H_2O dissolve 14.147 gms. of the salt at 20° . (Jantsch and Grunkraut, 1912-13)

GADOLINIUM SORBATE $Gd(C_5H_7O_2)_3$

0.001239 moles are dissolved in 1 liter of saturated solution in water at 20° . (Bergamini, 1949)

GADOLINIUM BENZENE SULFONATES

SOLUBILITY IN WATER

Salt	Formula	t°	Gms. Anhydrous Salt per 100 gms. H_2O	Authority
Gadolinium m-Nitrobenzene Sulfonate	$Gd[C_6H_4(NO_2)SO_3]_3 \cdot 7H_2O$	15	43.8	(Holmberg, 1907)
Gadolinium Bromonitrobenzene Sulfonate	$Gd[C_6H_3Br(NO_2)SO_3(1.4.2)]_3 \cdot 10H_2O$	25	6.31	(Katz and James, 1913)

GADOLINIUM ETHYLENEDIAMINE TETRA ACETATES

CH

SOLUBILITIES IN WATER
(Marsh, 1955)

$GdNa(COO)_2NC_2H_4N(COO)_2$		$GdK(COO)_2NC_2H_4N(COO)_2$		$GdNH_4(COO)_2NC_2H_4N(COO)_2$	
Gms. "hydrated salt" t° per liter		Gms. "hydrated salt" t° per liter		Gms. "hydrated salt" t° per liter	
2	11.7	2	26	2	86
25	36 (32.8)*	25	81	25	240
35	56	35	126		

*Gms. anhydrous salt per 1000 gm. solution (Moeller, Moss and Marshall, 1955).

GADOLINIUM COBALTICYANIDE $Gd[Co(CN)_6] \cdot \frac{2}{3}H_2O$

CH

1000 gms. aq. 10% hydrochloric acid dissolve 1.86 gms. of the salt at 25° . (James and Willard, 1916)

Gd GADOLINIUM

CO GADOLINIUM OXALATE $Gd_2(C_2O_4)_3 \cdot 10H_2O$ SOLUBILITY OF GADOLINIUM OXALATE IN AQUEOUS SOLUTIONS OF ACIDS AT 25°
(Sarver and Brinton, 1927)

The determinations were made gravimetrically by evaporating large volumes of the saturated solution.

Solvent concentration in normality	Gms. $Gd_2(C_2O_4)_3$ per 100 gms. sat. sol.	Solvent concentration in normality	Gms. $Gd_2(C_2O_4)_3$ per 100 gms. sat. sol.
0.1008 HCl	0.0024	0.248 HNO_3	0.0219
0.2576 "	0.0099	1.992 "	0.2785
0.5004 "	0.0329	4.054 "	0.9032
1.018 "	0.0938	2.0 "+ 0.1 $(COOH)_2$	0.0768
1.484 "	0.1563	3.03 "+ " "	0.2813
2.000 "	0.2457	4.00 "+ " "	0.5498
0.978 "+ 0.1 $(COOH)_2$	0.0061	2.0 "+ 0.5 $(COOH)_2$	0.0128
2.000 "+ " "	0.0525	3.03 "+ " "	0.0463
2.865 "+ " "	0.1448	4.0 "+ " "	0.1397
3.965 "+ " "	0.3777	4.0 "+ sat. "	0.0383
0.978 "+ 0.5 " "	0.0011	6.0 "+ " "	0.1227
2.000 "+ " "	0.0037	0.086 H_2SO_4	0.0086
2.865 "+ " "	0.0215	0.419 "	0.0401
3.965 "+ " "	0.0676	0.958 "	0.0988
1.484 "+ sat. "	0.0026	1.846 "	0.2047
4.0 "+ " "	0.0475	2.612 "	0.2970
6.0 "+ " "	0.1921	2.16 "	0.3005 (W.)
		3.11 "	0.4803 (W.)
		4.32 "	0.6956 (W.)
		6.175 "	1.128 (W.)

(W.) = Wirth, 1912

(W.) = Wirth, 1912

SOLUBILITY OF GADOLINIUM OXALATE IN ORGANIC SOLVENTS
(Grant and James, 1917)

Solvent	Gms. $Gd_2(C_2O_4)_3$ per 100 cc Solvent
Aq. 20% Methylamine Oxalate	0.069
" Ethylamine "	0.360
" Triethylamine "	0.883

GADOLINIUM MAGNESIUM NITRATES
NICKEL
COBALT
ZINC

NO

SOLUBILITY OF DOUBLE NITRATES OF GADOLINIUM AND OTHER METALS IN CONC.

NITRIC ACID OF $d_{16} = (-51.59 \text{ Gm. HNO}_3 \text{ per } 100 \text{ cc})$ AT 16°
(Jantsch, 1912)

Salt	Formula	Gms. Hydrated Salt per Liter Sat. Solution
Gadolinium Magnesium Nitrate	$[\text{Gd}(\text{NO}_3)_6]_2\text{Mg}_3 \cdot 24\text{H}_2\text{O}$	352.3
" Nickel "	" Ni_3 "	400.8
" Cobalt "	" Co_3 "	451.4
" Zinc "	" Zn_3 "	472.7

Data for the distribution of Gadolinium between aqueous nitric acid solutions and n-tributyl phosphate at 25° , 30° , 35° are given by Weaver, Kappelmann and Topp (1953).

GADOLINIUM OXIDE Gd_2O_3 O
GADOLINIUM HYDROXIDE $\text{Gd}(\text{OH})_3$ OH

SOLUBILITY IN WATER AT 25°

0.9×10^{-6} moles per liter ($K_{sp} = 1.8 \times 10^{-23}$) (Moeller and Fogel, 1951)
 1.4×10^{-6} " " " ($K_{sp} = 2.1 \times 10^{-22}$) (Moeller and Kremers, 1944)

GADOLINIUM Dimethyl PHOSPHATE $\text{Gd}(\text{CH}_3)_2\text{PO}_4)_3$ PO

SOLUBILITY OF GADOLINIUM DIMETHYL PHOSPHATE IN WATER
(Marsh, 1939)

The saturated solution at 0° was prepared by mechanical stirring for 3-4 hours. For the other temperatures the cold saturated solution was diluted somewhat and stirred occasionally for 3-4 hours.

t°	Gms. $\text{Gd}[(\text{CH}_3)_2\text{PO}_4]_3$ per 100 gms. H_2O	Gms. Gd_2O_3 per liter sat. sol.
0	37.0	126
25	24.2 (23)*	82.3
50	15.7	53.4
95	- (5.7)*	

*Morgan and James, 1914.

Ge GERMANIUM

SO GADOLINIUM SULFATE $Gd_2(SO_4)_3$

SOLUBILITY IN WATER

(Benedict, 1900; Jackson and Rienacker, 1930; Wirth, 1912; Bissell and James, 1916; Spedding and Jaffe, 1954)

t°	Gms. $Gd_2(SO_4)_3$ per 100 Gms. H ₂ O	Solid Phase	t°	Gms. $Gd_2(SO_4)_3$ per 100 Gms. H ₂ O	Solid Phase
0	3.98 (B.)	$Gd_2(SO_4)_3 \cdot 8H_2O$	25	2.4 (B.)	$Gd_2(SO_4)_3 \cdot 8H_2O$
10	3.3 (B.)	"		3.07 (W.)	"
14	2.8 (B.)	"		2.15 (B. & J.)	"
20	2.33 (J. & R.)	"		3.299 (S. & J.)	"
			34.4	3.26 (B.)	"
			40	1.77 (J. & R.)	"

SOLUBILITY OF GADOLINIUM SULFATE IN AQUEOUS SOLUTIONS OF:

Sodium Sulfate at 25°

(Bissell and James, 1916)

Gms. per 100 Gms. H ₂ O		Solid Phase
Na_2SO_4	$Gd_2(SO_4)_3$	
0	2.15	$Gd_2(SO_4)_3 \cdot 8H_2O$
0.43	2.06	"
0.47	0.76	$Gd_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$
1.26	0.17	"
3.01	0.07	"
7.46	0.05	"
27.40	0.05	"

Sulfuric Acid at 25°

(Wirth, 1912)

Gms. per 100 Gms. Sat. Sol.			Solid Phase
Normality of H ₂ SO ₄	$Gd_2O_3 = Gd_2(SO_4)_2$		
0	1.793	2.981	$Gd_2(SO_4)_3 \cdot 8H_2O$
0.1	1.98	3.291	"
0.505	2.365	3.931	"
1.1	2.29	3.807	"
2.16	1.789	2.974	"
6.175	0.528	0.8777	"
12.6	0.0521	0.0867	"

GERMANIUM Ge

Data for the solubility of germanium in liquid gallium from 200° to 958° are given by Keck and Broder, 1953.

GERMANIUM TETRACHLORIDE GeCl_4

Cl

MISCIBILITY OF GERMANIUM TETRACHLORIDE AND SULFUR DIOXIDE
(Bond and Crone, 1934)

The synthetic method was used and the temperatures of melting or disappearance of the second liquid layer determined.

t°	Gms. GeCl_4 per 100 gms. sat. sol.	t°	Gms. GeCl_4 per 100 gms. sat. sol.	t°	Gms. GeCl_4 per 100 gms. sat. sol.
-51.8(m.pt.)	100.	-4.9	63.98	-51.5	7.0
-75.0(-53.9)	98.80	-4.9	63.06	-55.2	6.26
-61.9(-55.0)	97.97	-4.7	59.87	-60.5(-58.0)	5.15
-53.0	97.97	-4.7	58.81	-67.1(-61.2)	4.21
-46.6	96.41	-4.9	52.37	-73.0(-64.5)	3.48
-31.0	93.72	-5.1	49.92	-76.1(-66.8)	3.07
-27.2	92.72	-5.5	45.00	-79.2(-66.8)	2.71
-24.2	91.76	-6.2	41.86	-86.0(-71.8)	2.17
-21.1	90.58	-7.4	37.78	-88.0(-72.8)	2.07
-15.0	87.42	-9.0	34.22	(-76.5)	1.55
-12.3	85.54	-10.1	31.95	(-76.5)	1.48
-9.2	82.24	-13.1	27.52	(-76.1)	0.94
-7.1	78.62	-24.6	17.52	(-75.9)	0.72
-6.1	75.36	-32.7	13.16	(-75.5)	0.00
-5.2	69.42	-36.4	11.31		
-5.2	68.78	-41.2	10.07		
-5.0	67.59				

The figures in parentheses
are melting points.

The following systems have been investigated:

$\text{GeCl}_4 + \text{GeBr}_4$	(1)	$\text{GeCl}_4 + \text{Methyl-o-Cresyl Ether}$	(3)
$\text{GeCl}_4 + \text{Diphenyl Ether}$	(2)	$\text{GeCl}_4 + \text{n-Propyl Phenyl Ether}$	(3)
$\text{GeCl}_4 + \text{Anisole}$	(3)	$\text{GeCl}_4 + \text{Tetra Hydro Pyran}$	(4)
$\text{GeCl}_4 + \text{Phenetole}$	(3)	$\text{GeCl}_4 + \text{Tetra Hydro Furan}$	(4)
$\text{GeCl}_4 + \text{Methyl-m-Cresyl Ether}$	(3)	$\text{GeCl}_4 + \text{Diethyl Ether}$	(4)
(1) Delwaulle, 1952		(3) Sisler, et. al., 1948	
(2) Sisler and Cory, 1947		(4) Sisler, Batey, Pfahler, and Mattair, 1948	

GERMANIUM FLUORIDES

F

SOLUBILITY OF GERMANIUM DOUBLE FLUORIDES IN WATER, EACH
DETERMINED SEPARATELY
(Müller, 1927)

Germanium Double Fluoride of:	Formula of Salt	Gms. Salt per 100 cc sat. solution at:					
		0°	10°	25°	30°	40°	80°
Lithium	GeLi_2F_6	-	-	53.92	-	-	-
Sodium	GeNa_2F_6	1.52	1.68	-	2.25	2.83	3.36
Potassium	GeK_2F_6	0.25	0.363	0.59	0.65	0.95	-
Rubidium	GeRb_2F_6	0.23	0.302	-	0.74	-	-
Caesium	GeCs_2F_6	0.84	0.98	1.89	2.28	-	-
Tellurium	GeTeF_6	14.13	-	-	34.58	-	-
Silver	GeAg_2F_6	-	-	-	88.03	-	-

Ge GERMANIUM

0 GERMANOUS OXIDE GeO

SOLUBILITY IN WATER AT 25°

Brown form	$2 \pm 1 \times 10^{-4}$ moles/liter	(Jolly and Latimer, 1952)
Yellow form	5.0×10^{-3} moles/liter	(Everest and Terrey, 1950)

0 GERMANIUM DIOXIDE GeO_2

100 gms. H_2O dissolve 0.405 gm. GeO_2 at 20°, and 1.07 gms. at 100°. (Winkler, 1887)

SOLUBILITY OF GERMANIUM DIOXIDE IN WATER (Schwarz and Huf, 1931)

The Germanium dioxide was prepared by distilling germanite 4-5 times in a stream of chlorine, freeing the tetrachloride thus obtained of chlorine by means of Hg, and hydrolyzing in distilled water. Several determinations made with such samples gave the following results at 20°.

Preliminary treatment of sample	Hours allowed for saturation	Gms. GeO_2 per 100 cc sat. sol.
Hydrolysis 6 hrs. with 30.6% H_2O	30	0.534
" with 3.7% H_2O drying.		
over KOH 14 hrs., age 58 hrs.	35	0.596
Hydrolysis of GeO_2 , heated 2 hrs. at 600°	28-51	0.430
" " " " " " 400°	143	0.349
Boiling in H_2O (hydrolysed, dried)	-	0.747
Melted GeO_2	32	0.572

The following results at different temperatures were obtained with a preparation which had been heated to 600° and was used in the ratio of 0.4 gm. per 100 cc H_2O .

t°	11°	20°	26°	35°	41°
Gms. GeO_2 per 100 cc sat. sol.	0.396	0.430	0.470	0.551	0.617

A table of results is also given showing that the variations of solubility of GeO_2 in water depends upon the preliminary treatment of the sample as well as upon the ratio of solid to water used in the determination (?).

The properties of the modifications of GeO_2 obtained by various means are described by Müller and Blank, 1924; and Müller, 1926.

SOLUBILITY OF GERMANIUM DIOXIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID, SULFURIC ACID AND SODIUM HYDROXIDE AT 25° (Pugh, 1929)

The GeO_2 was prepared from the pure disulfide by repeated treatment with HNO_3 and ignition to bright red heat. The oxide, which had not been allowed to fuse, was ground with water, washed until free of H_2SO_4 and

finally reignited. It was found that 8-10 days agitation were necessary for attainment of equilibrium.

Results for aq. Hydrochloric Acid		Results for aq. Sulfuric Acid		Results for aq. Sodium Hydroxide	
Gm. Mola. HCl per liter	Gms. GeO_2 per 100 cc sat. sol.	Gm. Mols. H_2SO_4 per liter	Gms. GeO_2 per 100 cc sat. sol.	Gm. Mols. per liter sat. sol.	
				NaOH	GeO_2
0.0	0.4470	0.0	0.4470	0.0	0.0428
0.25	0.4115	0.50	0.3550	0.00125	0.0440
0.50	0.3810	0.98	0.2805	0.0025	0.0483
1.50	0.2600	1.50	0.2000	0.005	0.0545
2.0	0.2185	2.05	0.1600	0.010	0.0675
2.925	0.1544	2.52	0.1305	0.0125	0.0746
3.85	0.1140	3.02	0.099	0.025	0.1115
4.35	0.0920	3.50	0.074	0.050	0.1693
5.20	0.074	4.0	0.050	0.100	0.2280
5.72	0.102	4.5	0.041		
6.23	0.1820	5.85	0.019		
6.85	0.3164	7.95	0.009		
7.62	0.7660	(95%)	0.140		

Fusion-point data for mixtures of $\text{GeO}_2 + \text{K}_2\text{O}$ and $\text{GeO}_2 + \text{Na}_2\text{O}$ are given by Schwarz and Heinrich, 1932.

GERMANIUM (Mono) SULFIDE GeS GERMANIUM (Di) SULFIDE GeS_2

S

100 gms. H_2O dissolve 0.24 gm. GeS . 100 gms. H_2O dissolve 0.45 gm. GeS_2 . (Winkler, 1887)

100 gms. liquid NH_3 dissolve 0.0473 gm. GeS (= 0.0031 Gm. Mol. GeS per liter) at -33° .

100 gms. liquid NH_3 dissolve 3.112 gm. GeS_2 (= 0.1551 Gm. Mol. GeS_2 per liter) at -32.9° . (Johnson and Wheatley, 1934)

HYDROGEN H_2

SOLUBILITY OF HYDROGEN IN WATER

(Winkler, 1891; Bohr and Bock, 1891; Timofejew, 1890; Milligan, 1924; Morrison and Billett, 1952)

β = Bunsen Absorption Coefficient = ml. gas (measured at 0° , 760 mm) dissolved in 1 ml. of liquid when the partial pressure of the gas is 1 atm.

β' = "Solubility" = ml. gas (measured at 0° , 760 mm) dissolved in 1 ml. of liquid when the total pressure (gas + vapor pressure of the liquid at the temperature of the experiment) is 1 atmosphere.

H HYDROGEN

q = the weight of gas in grams dissolved by 100 gms. of pure solvent, at the indicated temperature and a total pressure (that is, the partial pressure of the gas plus the vapor pressure of the liquid at the absorption temperature) of 760 mm.

t°	β	β'	q	t°	β	β'	q
0	0.0214	0.0214	0.000193	30	0.0170	0.0163	0.000147
5	0.0204	0.0203	0.000184	40	0.0164	0.0153	0.000139
10	0.0195	0.0193	0.000176	50	0.0161	0.0141	0.000129
15	0.0188	0.0185	0.000169	60	0.0160	0.0129	0.000119
20	0.0182	0.0178	0.000162	80	0.0160	0.0085	0.000079
25	0.0175	0.0171	0.000156	100	0.0160	0.0000	0.000000

SOLUBILITY OF HYDROGEN IN WATER UP TO ABOUT 25 ATM. PRESSURE

Results of Cassuto, 1904

[Rounded values for k read from a plot of the author's data, where $l = kP$]

P = Total Pressure

l = Ostwald solubility coefficient (ml. gas (at 1 atm., t° of the expt.) dissolved in 1 ml solvent when the partial pressure of the gas is 1 atm.

Total Pressure atm.	k	
	19.5°	23°
100/76	0.01797	0.01736
200/76	.01795	.01735
300/76	.01793	.01732
400/76	.01780	.01726
500/76	.01761	.01708
600/76	.01731	.01685
700/76	.01692	.01651
800/76	.01644	.01610

Results of

Pray, Schweickert and Minnich, 1952 (PSM)
Ipatieff and Teodorovich, 1934 (IT)

pp. H_2 cc H_2 (STP) pp. H_2 cc H_2 (STP)
P.S.I.A. per gm. H_2O P.S.I.A. per gm. H_2O

125°F. (PSM)

200	0.33
300	.41
350	.45

435°F. (IT)

100	0.22
200	.49
300	.75
375	.94
500	1.26

300°F. (IT)

100	0.13
200	.28
300	.40
375	.52
500	.70

500°F. (PSM)

100	0.39
200	.91
300	1.25

345°F. (IT)

100	0.15
200	.30
300	.43
375	.56
500	.75

600°F. (PSM)

100	0.65
200	1.32
300	2.01

650°F. (PSM)

390°F. (IT)

100	0.18
200	.34
300	.52
375	.68

100	1.40
115	1.63
120	1.68
125	1.74

SOLUBILITY OF HYDROGEN IN WATER AT VARIOUS TEMPERATURES AND AT
25 TO 1000 ATMOSPHERES PRESSURE

(Wiebe and Gaddy, 1934; Wiebe, Gaddy and Heins, Jr., 1932 (at 25°))

The authors used a simple bubbling-type of apparatus made of a steel cylinder with pressure valves. Equilibrium was approached from both lower and higher pressures. The experimental accuracy was about 0.5 per cent except at the lower pressures. The hydrogen contained 0.1 per cent N_2 for which a correction proportional to its mol fraction was applied. A correction for change of vapor pressure due to the gas pressure on the liquid, was made. By a sensitive method of plotting deviations the experimental data were smoothed with respect to both pressure and temperature to obtain the following interpolated solubility values.

cc H_2 (reduced to 0° and 760 mm) dissolved by 1.0 gm. H_2O at:						
Pressure in Atmospheres	0°	10°	20°	25°	30°	40°
25	0.5363	0.4870	0.4498	0.436	0.4263	0.4133
50	1.068	0.9690	0.8945	0.867	0.8475	0.8215
75	1.601	1.453	1.341	-	1.271	1.232
100	2.130	1.932	1.785	1.728	1.689	1.638
150	3.168	2.872	2.649	-	2.508	2.432
200	4.187	3.796	3.499	3.39	3.311	3.210
300	6.139	5.579	5.158	-	4.897	4.747
400	8.009	7.300	6.766	6.57	6.430	6.245
500	9.838	8.980	8.328	-	7.922	7.705
600	11.626	10.610	9.856	9.58	9.390	9.135
700	13.370	12.214	11.362	-	10.818	10.524
800	15.013	13.746	12.808	12.46	12.218	11.889
900	16.548	15.215	14.217	-	13.583	13.230
1000	18.001	16.623	15.592	15.20	14.928	14.569

cc H_2 (reduced to 0° and 760 mm) dissolved by 1.0 gm. H_2O at:						
Pressure in Atmospheres	50°	60°	70°	80°	90°	100°
25	0.4067	0.4053	0.4093	0.4203	0.4385	0.4615
50	0.8090	0.8095	0.8171	0.8385	0.8720	0.9120
75	1.212	1.211	1.224	1.254	1.298	1.355
100	1.612	1.610	1.628	1.667	1.727	1.805
150	2.395	2.393	2.422	2.485	2.576	2.681
200	3.165	3.168	3.208	3.286	3.402	3.544
300	4.695	4.692	4.746	4.866	5.042	5.220
400	6.166	6.173	6.249	6.392	6.600	6.841
500	7.613	7.625	7.717	7.885	8.129	8.429
600	9.017	9.016	9.131	9.324	9.665	9.994
700	10.389	10.405	10.527	10.757	11.093	11.512
800	11.735	11.746	11.893	12.169	12.555	12.980
900	13.072	13.084	13.233	13.533	13.946	14.394
1000	14.404	14.407	14.557	14.867	15.303	15.775

The authors extrapolated the results at 25 atmospheres to lower pressures by means of Henry's law to obtain values at one atmosphere. These results when converted to terms of the Bunsen and Ostwald coefficients agree fairly well with the data of Winkler except at the higher temperatures.

(See next page)

H HYDROGEN

Results differing from the above are given by Frolich, Touch, Hogan and Peer, 1931 (25°, 50-150 atm.-data much higher) and by Ipatiew, Jr., Drushima - Artemowitsch, and Tichomirow, 1931, 1932 (0-100°, 20-140 atm.-data up to 15% lower).

Results for the solubility of hydrogen in water at temperatures up to 225°, at pressures between 30-100 atm. are given by Ipatieff, Jr., and Theodorovich, 1934.

SOLUBILITY OF A MIXTURE OF 76.42 PER CENT HYDROGEN AND 25.58 PER CENT NITROGEN IN WATER AT 25° AND AT 50 TO 1000 ATMOSPHERES PRESSURE (Wiebe and Gaddy, 1936)

The approximately 3:1 mixture of hydrogen and nitrogen was prepared by burning hydrogen in air. The amount of argon introduces an uncertainty of about 0.2 per cent. The same bubbling method was used as previously employed by the authors for determinations of the solubility of hydrogen in water at different temperatures and pressures. The composition of the gas in the two phases was analyzed by means of a modified form of thermal conductivity apparatus containing glass instead of the usual metal cells.

Pressure in atmospheres	cc H ₂ (reduced to 0° and 760mm) dissolved in 1.0 gms. H ₂ O	Av. per cent H ₂ in the gas present in the liquid phase	Av. per cent H ₂ in the gas present in the gas phase
50	0.8349	80.17	76.42
100	1.643	80.89	76.42
200	3.209	82.68	76.42
400	6.068	84.33	76.42
600	8.809	84.94	76.42
800	11.327	85.32	76.42
1000	13.724	85.81	76.42

Thermodynamic calculations of the solubility of Hydrogen and Nitrogen and their mixtures in water at pressures up to 1000 atmospheres based upon the above results are given by Krichevsky and Kasarnovsky, 1935, 1936, and by Kielland, 1936.

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF ACIDS AND BASES AT 25° (Geffcken, 1904)

Normality of Solvent	Solubility of H (t_{25} = Ostwald Expression) in Solutions of:						
	HCl	HNO ₃	H ₂ SO ₄	CH ₃ COOH	CH ₂ ClCOOH	KOH	NaOH
0.0	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193
0.5	0.0186	0.0188	0.0185	0.0192	0.0189	0.0167	0.0165
1.0	0.0179	0.0183	0.0177	0.0191	0.0186	0.0142	0.0139
2.0	0.0168	0.0174	0.0163	0.0188	0.0180	...	0.0097
3.0	0.0159	0.0167	0.0150	0.0186	...	...	0.0072
4.0	...	0.0160	0.0141	0.0186	...	...	0.0055

The above figures for the concentrations of acids and bases were calculated to grams per liter, and these values with the corresponding t_{25} values for the solubility of hydrogen, plotted on cross-section paper.

(Contd.)

From the resulting curves, the following table was read:

Grams Acids and Bases per Liter	Solubility of H (α_{25} - Ostwald Expression) in Solutions of:						
	HCl	HNO ₃	H ₂ SO ₄	CH ₃ COOH	CH ₂ ClCOOH	KOH	NaOH
0	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193
20	0.0185	0.0189	0.0186	0.0192	0.0191	0.0172	0.0165
40	0.0179	0.0186	0.0180	0.0191	0.0190	0.0153	0.0140
60	0.0173	0.0183	0.0174	0.0190	0.0188	0.0135	0.0117
80	0.0167	0.0180	0.0168	0.0189	0.0187	...	0.0097
100	0.0160	0.0179	0.0162	0.0189	0.0185	...	0.0082
150	...	0.0171	0.0148	0.0188	0.0182	...	0.0058
200	...	0.0165	0.0140	0.0186	0.0179	...	...
250	...	0.0160	...	0.0184	...	...	...*

*At 25°, 100 atm. 1 ml. of 20% NaOH Solution dissolves 0.417 ml. (S.T.P.) of H₂. (Ipetiew, Jr., Drushina-Artemowitsch and Tichonirrow, 1931-1932)

THE SOLUBILITY OF HYDROGEN IN CONC. H₂SO₄ AT 20°
(Christoff, 1906)

H ₂ SO ₄	0	35.82	61.62	95.6
α_{20}	0.0208	0.00954	0.00708	0.01097

SOLUBILITY OF HYDROGEN IN ACETIC ACID SOLUTIONS
(Marted and Moon, 1936)

t°	d. of solvent at 5°	V.P. of solvent at t°	β	t°	d. of solvent at t°	V.P. of solvent at t°	β
18.6	1.0507	11.0	0.0558	37.5	1.031	30.0	0.0620
20.0	1.049	12.0	0.0566	45.0	1.023	45.0	0.0649
20.0	-	-	(0.0575)*	54.0	1.011	72.0	0.0676
25	-	-	(0.0580)*	64.8	1.000	109.0	0.0714
30.0	1.039	21.0	0.0594	74.8	0.989	166.0	0.0742
37.5	1.031	30.0	0.0620				

*Just, 1901

SOLUBILITY OF HYDROGEN IN AQUEOUS PROPIONIC ACID SOLUTIONS
(Braun, 1900)

Gms. C ₂ H ₅ COOH per 100 Gms. Solution	Coefficient of Absorption of Hydrogen (β)				
	5°	10°	15°	20°	25°
2.63	0.02245	0.0214	0.0200	0.0188	0.0172
3.37	0.0222	0.0212	0.0199	0.0187	0.0171
5.27	0.0224	0.0212	0.0198	0.0184	0.0171
6.50	0.0218	0.0209	0.0193	0.0183	0.0169
9.91	0.0213	0.0203	0.0191	0.0178	0.0160

H HYDROGEN

SOLUBILITY OF HYDROGEN IN AQUEOUS SALT SOLUTIONS

Salt

AlCl₃

Solubility

(Data of Steiner (1894) at 15°)

Normality of AlCl ₃	Abs. coeff. β	Normality of AlCl ₃	Abs. coeff. β
0	0.01883	4	0.00810
1	.01511	5	.00667
2	.01221	6	.00550
3	.00993		

BaCl₂

(Data of Braun, 1900)

Gms. BaCl ₂ per 100 Gms. Solution	Coefficient of Absorption (β) of Hydrogen at:				
	5°	10°	15°	20°	25°
0.00	0.0237	0.0221	0.0206	0.0191	0.0175
3.29	0.0211	0.0198	0.0185	0.0172	0.0157
3.6	0.0209	0.0197	0.0184	0.0170	0.0156
6.45	0.0196	0.0186	0.0173	0.0161	0.0147
7.00	0.0194	0.0183	0.0172	0.0159	0.0146

CaCl₂

Data of Gordon (1895) at 15°

Gms. CaCl ₂ per 100 g. Sol.	Moles CaCl ₂ per Liter	Absorption Coefficient (β)
0.0	0.0	0.01883
3.45	0.321	0.01619
6.10	0.578	0.01450
11.33	1.122	0.01138
17.52	1.1827	0.00839
26.34	2.962	0.00519

Data of Steiner (1894) at 15°

Normality of CaCl ₂	Absorption Coefficient (β)
0	0.01883
1	.01493
2	.01195
3	.00958
4	.00780
5	.00635
6	.00510

K₂CO₃

Results of Gordon (1895) at 15°

Gms. K ₂ CO ₃ per 100 g. Sol.	Moles K ₂ CO ₃ per Liter	Absorption Coefficient β
0.0	0.0	0.01883
2.82	0.209	0.01628
8.83	0.690	0.01183
16.47	1.376	0.00761
24.13	2.156	0.00462
41.81	4.352	0.00160

Results of Steiner (1894) at 15°

N _{K₂CO₃}	β
0	0.01883
1	.01338
2	.00967
3	.00700
4	.00508
5**	0.00372
6	.00273
7	.00206
9	.00158

SOLUBILITY OF HYDROGEN IN AQUEOUS SALT SOLUTIONS---Contd.

Salt	Solubility							
KCl	Data of Gordon (1895) at 15°			Data of Steiner (1894) at 15°		Data of Knopp (1904) at 20°		
	Gms. KCl per 100 g. Sol.	Moles KCl per Liter	Absorption Coefficient β	Nor- mality of KCl	Absorption Coefficient β	Gms. KCl per 100 g. Sol.	β	Density
	0.0	0.0	0.01883	0	0.01883	1.089	0.01823	1.0052
	3.83	0.526	0.01667	1	.01502	2.123	0.01757	1.0118
	7.48	11.051	0.01489	2	.01217	4.070	0.01661	1.0243
	12.13	1.755	0.01279	3	.00996	6.375	0.01531	1.0394
	19.21	2.909	0.01012	4	.00820	7.380	0.01472	1.0460
	22.92	3.554	0.00892			13.612	0.01255	1.0875
	Setschenow coefficients $K = \left(\log \frac{S_0}{S} / c \right)$ of Morrison and Billet, 1952 (See p. 1076 for S_0 (Soly in H_2O) values, c = moles per 1000 gms. H_2O)							
	t°	12	30	50	72			
	k	0.088	0.081	0.066	0.043			
KNO ₃	Data of Gordon (1895) at 15°			Data of Steiner (1894) at 15°		Data of Knopp (1904) at 20°		
	Gms. KNO ₃ per 100 g. Sol.	Moles KNO ₃ per Liter	Absorption Coefficient β	Nor- mality of KNO ₃	Absorption Coefficient β	Gms. KNO ₃ per 100 g. sol.	β	Density
	0.0	0.0	0.01883	0	0.01883	1.224	0.01835	1.0059
	4.73	0.482	0.01683	1	.01524	2.094	0.01818	1.0013
	8.44	0.879	0.01559	2	.01276	4.010	0.01785	1.0236
	16.59	1.820	0.01311	3	.01076	5.925	0.01743	1.0359
	21.46	2.430	0.01180			7.742	0.01667	1.0477
						13.510	0.01436	1.0865
	Setschenow coefficients $K = \left(\log \frac{S_0}{S} / c \right)$ of Morrison and Billet, 1952 (See p. 1076 for S_0 (Soly in H_2O) values, c = equivalents per 1000 gms. H_2O .)							
	t°	12	30	50	72			
	k	0.112	0.100	0.105	0.095			
LiCl	Setschenow coefficients $K = \left(\log \frac{S_0}{S} / c \right)$ of Morrison and Billet, 1952 (See p. 1076 for S_0 (Soly in H_2O) values, c = moles per 1000 gms. H_2O)							
	t°	12	30	50	72			
	k	0.064	0.065	0.061	0.054			

SOLUBILITY OF HYDROGEN IN AQUEOUS SALT SOLUTIONS--Contd.

Salt	Solubility					
LiCl	Data of Gordon (1895) at 15°			Data of Steiner (1894) at 15°		
	Gms. LiCl per 100 g. Sol.	Moles LiCl per Liter	Absorption Coefficient (β)	Normality of LiCl	Absorption Coefficient (β)	
	0.0	0.0	0.01883	0	0.01883	
	3.48	0.835	0.01619	1	.01574	
	7.34	1.800	0.01370	2	.01325	
	14.63	3.734	0.0099	3	.01121	
				4	.00949	
MgSO ₄	Data of Gordon (1895) at 15°			Data of Steiner (1894) at 15°		
	Gms. MgSO ₄ per 100 g. Sol.	Moles MgSO ₄ per Liter	Absorption Coefficient (β)	Normality of MgSO ₄	Absorption Coefficient (β)	
	0.0	0.0	0.01883	0	0.01883	
	4.97	0.433	0.01501	1	.01451	
	10.19	0.936	0.01159	2	.01120	
	23.76	2.501	0.00499	3	.00856	
				4	.00659	
			5	.00499		
NH ₄ NO ₃	Data of Knopp (1904) at 20°					
	Gms. NH ₄ NO ₃ per 100 gms. sat. sol.	β	Density	Gms. NH ₄ NO ₃ per 100 gms. sat. sol.	β	Density
	0.00	0.0188	...	4.823	0.01773	1.0182
	1.037	0.01872	1.0027	6.773	0.01744	1.0262
	2.167	0.01845	1.0072	11.550	0.01647	1.04652
	3.378	0.01823	1.0122			
Na ₂ CO ₃	Data of Gordon (1895) at 15°			Data of Steiner (1894) at 15°		
	Gms. Na ₂ CO ₃ per 100 Gms. Solution	Moles Na ₂ CO ₃ per Liter	Absorption Coefficient (β)	Normality of Na ₂ CO ₃	Absorption Coefficient (β)	
	0.0	0.0	0.01883	0	0.01883	
	2.15	0.207	0.01639	1	.01340	
	8.64	0.438	0.01385	2	.00699	
	11.53	1.218	0.00839			

SOLUBILITY OF HYDROGEN IN AQUEOUS SALT SOLUTIONS--Contd.

Salt

Solubility

NaCl

Data of Braun (1900) and Gordon (1895)

Gms. NaCl per 100 Gms. Solution	Coefficient of Absorption of Hydrogen (8)				
	5°	10°	15°	20°	25°
1.25	0.0218	0.0205	0.0191	0.0177	0.0162
3.80	0.0198	0.0188	0.0176	0.0162	0.0148
4.48	0.0192	0.0182	0.0171	0.0159	0.0143
6.00	0.0184	0.0175	0.0164	0.0153	0.0138
14.78	...	...	0.0093	...	...
23.84	...	...	0.00595	...	...

Data of Steiner (1894) at 15°

N _{NaCl}	0	0.15	1	2	3	4	5
β _{H₂}	0.01883	0.1559*	0.01478	0.01144	0.00880	0.00699	0.00573

*cc H₂ per cc sat. sol. (Van Slyke and Sendroy Jr., 1928)

Setschenow coefficients $K = \left(\log \frac{S_0}{S} / c \right)$ of Morrison and Billet, 1952
 (See p. 1076 for S_0 (Soly in H₂O) values, c = moles per 1000 gms. H₂O)

t°	12	30	50	72
k	0.097	0.092	0.082	0.066

NaNO₃Data of Gordon
(1895) at 15°Data of Steiner
(1894) at 15°Data of Knopp
(1904) at 20°

Gms. NaNO ₃ per 100 g. Sol.	G. M. NaNO ₃ per Liter	Absorption Coefficient (β)	N _{NaNO₃}	β	Gms. NaNO ₃ per 100 g. Sol.	β	Density
0.0	0.0	0.01883	0	0.01883	1.041	0.01839	1.0052
5.57	0.679	0.01603	1	.01496	2.192	0.01774	1.0130
11.16	1.413	0.0137	2	.01201	4.405	0.01694	1.0282
19.77	2.656	0.01052	3	.00984	6.702	0.01518	1.0411
37.43	5.711	0.00578	4	.00808	12.637	0.0130	1.08667
			5	.00667			
			6	.00542			

Na₂SO₄Data of Gordon
(1895) at 15°Data of Steiner
(1894) at 15°

Gms. Na ₂ SO ₄ per 100 Gms. Solution	G. M. Na ₂ SO ₄ per Liter	Absorption Coefficient (β)	Normality of Na ₂ SO ₄	Absorption Coefficient (β)
0.0	0.0	0.01883	0	0.01883
4.58	0.335	0.01519	1	.01370
8.42	0.638	0.0154	2	.00991
16.69	1.364	0.00775	3	.00710

SOLUBILITY OF HYDROGEN IN AQUEOUS SALT SOLUTIONS--Contd.

Salt	Solubility					
ZnSO ₄	Data of Steiner (1894) at 15°					
Normality of ZnSO ₄	0	1	2	3	4	5
Abs. coeff. β_{H_2}	0.01883	0.01446	0.0143	0.00852	0.00667	0.00510

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF GLYCEROL

[Additional data for this system are given by Muller, C. 1912-13]

t°	Results at 14° and 21° (Henkel, 1905, 1912)		Results at 25° (Drucker and Moles, 1910)		
	Wt. % Glycerol	Absorp. Coef. β (See p. 1075)	Wt. % Glycerol	$\frac{d_{25}}{\text{Sat. Sol.}}$	ℓ_{25} (Ostwald Expression)
14	0	0.0193	0	1	0.0196
"	2.29	0.0189	4	1.0101	0.0186
"	5.32	0.0186	10.5	1.0260	0.0178
"	8.57	0.0182	22	1.0542	0.0154
"	10.83	0.01815	49.8	1.1290	0.0099
"	15.31	0.01765	50.5	1.1300	0.0097
21	0	0.0184	52.6	1.1365	0.0090
"	2.29	0.0181	67	1.1752	0.0067
"	5.68	0.0177	80	1.2113	0.0051
"	6.46	0.0176	82	1.2159	0.0051
"	10.40	0.0171	88	1.2307	0.0044
"	18.20	0.0160	95	1.2502	0.0034

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF CANE SUGAR AND OF GRAPE SUGAR (SUCROSE AND DEXTROSE)

Results of Miller, C. 1912-13

IN SUCROSE SOLUTIONS				IN DEXTROSE SOLUTIONS			
t°	Wt. % Cane Sugar	Sp. Gr. Sat. Sol.	Abs. Coef. β_{15}	t°	Wt. % Cane Sugar	Sp. Gr. Sat. Sol.	Abs. Coef. β_{20}
15.2	5.04	$d_{15} = 1.019$	0.0173	19.3	0	...	0.0184
11.6	14.7	$d_{11} = 1.060$	0.0151	20.5	12.2	$d_{20} = 1.048$	0.0160
12	20.26	$d_{11} = 1.084$	0.0146	20.5	20.7	$d_{20} = 1.084$	0.0145
12.7	20.86	$d_{13} = 1.128$	0.0126	21.1	32.56	$d_{20} = 1.130$	0.0125
11.8	31.74	$d_{12} = 1.138$	0.0119	21.8	45.8	$d_{20} = 1.199$	0.0102
13.3	39.65	$d_{13.5} = 1.175$	0.0103	21.2	59	$d_{20} = 1.266$	0.0078
12.6	42.04	$d_{12.5} = 1.195$	0.0094				

(Contd.)

(Contd.)

Results of Gordon, 1895 and
Steiner, 1894 at 15°

Gms. Sucrose per 100 gms. Solution	Gm. Mols. Sugar per Liter	Absorption Coefficient
16.67	0.520	0.01561 (G)
30.08	0.993	0.01284 (G)
-	1.0	0.01280 (S)
47.65	1.699	0.00892 (G)
-	2.0	0.00731 (S)

Results of Hufner, 1906-07

t°	Gms. Dextrose per liter solvent	Abs. coef. β
20.11	0.0	0.0181
20.00	41.45	0.0176
20.25	87.3	0.0166
20.28	174	0.0152

Results of Garner and Masson, 1921 at 15°:

RATIO OF THE SOLUBILITY OF HYDROGEN IN WATER TO ITS SOLUBILITY
IN AQUEOUS SOLUTIONS OF SUCROSE

Moles Sucrose per liter	$\frac{8 \text{ H}_2\text{O}}{\beta \text{ soln.}}$	Moles Sucrose per liter	$\frac{\beta \text{ H}_2\text{O}}{\beta \text{ soln.}}$
0.292	1.11	1.169	1.61
0.585	1.23	1.460	1.87
0.877	1.39	1.755	2.17

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF CHLORAL HYDRATE AT 20°

Data of Müller, C. (1912-13)

Gms. Chloral Hydrate per 100 Gms. Aq. Sol.	d ₂₀ of Aq. Solution	Abs. Coef. β
15.5	1.0722	0.01724
28.3	1.143	0.01540
46.56	1.2505	0.01375
52.0	1.2870	0.01280
63.0	1.371	0.01243
68.0	1.4097	0.01270
78.4	1.4993	0.01380

Data of Knopp (1904)

Gms. Chloral Hydrate per 100 Gms. Aq. Sol.	Density of Solutions	Absorption Coefficient β
4.91	1.0202	0.01839
7.69	1.0320	0.01802
14.56	1.0669	0.01712
29.50	1.1466	0.01542
38.42	1.1982	0.01440
49.79	1.2724	0.01353
63.90	1.3743	0.01307

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF SEVERAL COMPOUNDS
(Data of Hufner, 1906-07)

Aqueous Solution of:	Conc. of Solvent Gms. per Liter	t°	Absorption Coef. β
Water alone	0	20.11	0.0181
Urea	60	20.17	0.0170
Acetamide	59	20.11	0.0180
Alanine	89	20.08	0.0156
Glycocol	75	20.16	0.0158

(Data of Findlay and Shen, 1912)

α = Ostwald coefficient = ml. H_2 (1 atm., t° of expt.) dissolved in 1 ml. of H_2O when the partial pressure of the gas is 1 atm.

Dextrin aq.			Starch aq.			Gelatin aq.*	
Gms. Dextrin per 100 cc	Sp. Or.	α_{25}	Gms. Starch per 100 cc	Sp. Or.	α_{25}	Gms. Gelatin per 100 cc	α_{25}
3.98	1.012	0.0194	2.01	1.005	0.0194	1.53	0.0194
8.58	1.019	0.0191	3.56	1.011	0.0189	2.69	0.0189
8.12	1.028	0.0188	7.13	1.024	0.0181	4.74	0.0185
19.20	1.066	0.0174	9.29	1.032	0.0182	5.71	0.0182

*further data in gelatin solutions are given by Eversole and Hanson, 1940

SOLUBILITY OF HYDROGEN IN OX BLOOD SERUM AND CELLS AT 38° , 1 atm. (Van Slyke and Sendroy Jr., 1928)

Solvent	Abs. Coef. cc H_2 per 1 cc sat. sol.
Water	0.01620
Aq. 0.15 normal NaCl	0.01559
Ox Blood Serum	0.01533
Ox Blood Cells	0.01454

SOLUBILITY OF HYDROGEN IN METHANOL (Data of Just, 1901)

$$\alpha_{20^\circ} = 0.0902$$

$$\alpha_{25^\circ} = 0.0945$$

(Data of Frolich, Touch, Hogan and Peer, 1931 at 25° .)

Pressure (atm.)	40	60	80	100	150
cc H_2 (S.T.P.) dissolved by 1 ml. of solvent	3.3	5.0	7.0	8.5 (8.695)*	12.5

*Ipatiew, Jr., Drushina-Artemowitsch and Tichonirrow, 1931-32.

Krichevskii and Efremova, 1951 measured the solubility of H_2 in methanol at 25° between 50 and 600 atm. The results are expressed in partial molar volumes. Data for $H_2 + N_2$ mixtures up to 400 atm. are also given.

Krichevskii and Zhavoronkov, 1937 give data between $21-140^\circ$ at 300 atm.

Results at $25-100^\circ$ from 80-800 atm. are given by Michels, de Graaf and van der Somme, 1943.

SOLUBILITY OF HYDROGEN IN ETHANOL
(Results of Mærted and Moon, 1936)

These data are higher than those of earlier workers, given below.

t°	Density of solvent at t°	V.P. of Solvent (mm. Hg) at t°	Abs. Coef. β
0.6	0.8063	12.2	0.0718
10.0	0.7978	23.8	0.0737
20.3	0.7890	44.0	0.0769
25.0	0.7851	60.0	0.0784
30.0	0.7808	78.0	0.0802
40.0	0.7730	133.0	0.0840
50.0	0.7633	220.0	0.0864

(Data of earlier investigators - values for β)

t°	Bunsen (1877) Recalc'd by Henrich (1892)	Carius (1855)	Timofeiew, 1890	
			in 98.8% alcohol	in 7% alcohol
0	0.06930	0.06925	0.0676	-
4	-	-	-	0.0749
5	.06851	.06853	-	-
6.2	-	-	0.0693	-
10	.06781	.06786	-	-
13.4	-	-	0.0705	-
15	.06720	.06725	-	-
18.8	-	-	-	0.0740
20	.06667	.06668	0.0804*	-
25	.06622	.06616	0.0819*	-

*Just, 1901

SOLUBILITY OF HYDROGEN IN AQUEOUS ETHANOL SOLUTIONS AT 20°, 1 ATM.
(Lubarsch, 1889)

(Also see the table above)

Wt. % Alcohol	Vol. % Absorbed H ₂	Wt. % Alcohol	Vol. % Absorbed H ₂
0.0	1.93	28.57	1.04
9.09	1.43	33.33	1.17
16.67	1.29	50.00	2.02
23.08	1.17	66.67	2.55

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS

(1) Horiuti, 1931 (done with great precision); (2) Just, 1901; (3) Settler, 1940; (4) Cook, 1954; (5) Krichevskii and Efremova, 1950; (6) Christoff, 1912; (7) Mærted and Moon, 1936; (8) DuPont, 1955; (9) Gjaldbaek, 1952; (10) Gonikberg, 1940; (11) Frolich, Touch, Hogan and Peer, 1931; (12) Nelson and Bonnell, 1943; (13) Lachowicz, Newitt, and Weale, 1955; (14) Kirjeew and Romantchouk, 1936; (15) Cauquil, 1927; (16) Schaffer and Haller, 1943; (17) Vibrans, 1930; (18) Nasini and Corinaldi, 1932; (19) Peter and Weinert, 1955; (20) Gniewasz and Walfisz, 1887; (21) Newitt and Weale, 1948; (22) Carpenter, 1947; (23) Venable and Fuwa, 1922; (24) Barner, 1941; (25) Ipatiev and Levina, 1935; (26) Ipatiev, Jr., Drushima-Artemowitsch, and Tichonirrow, 1931-32.

Solvent	Ref.	Solubility			
Acetone	(1)	t^*	l	t^*	l
		-81.9	0.0273	0.0	0.0783
		-60.7	0.0376	+20.9	0.0968
		-40.6	0.0498	40.0	0.1131
		-20.9	0.0618		
	(2)	$l_{20} = 0.0703$	$l_{25} = 0.0764$		
Benzene	(1)	$l_{7.0} = 0.0585$, $l_{22.9} = 0.0700$, $l_{41.3} = 0.0844$, $l_{62.8} = 0.1051$			
	(2)	$l_{20} = 0.0707$, $l_{25} = 0.0756$			
	(3)	35.2°, 150.2 atm: 11.77 cc H ₂ /gm. solvent 72.6°, 148.0 atm: 15.11 cc H ₂ /gm. solvent			
	(4)	10°, 2.88 moles H ₂ /atm./gm. solvent 35°, 3.59 m/atm./gm. 15°, 3.03 " " " 45°, 3.89 " " 25°, 3.30 " " " "			
	(5)	Data given at 25° up to 500 atm. pressure.			
	(25)	" " " 25-300°, 50 to 300 atm. pressure.			
	(26)	At 25°, 100 atm. 694.4 ml. H ₂ (S.T.P.) dissolve in 100 ml benzene.			
	(7)	t^*	Density of solvent at t^*	V.P. of solvent at t^*	Ads. Coef. β
		0.5	0.9001	25.0	0.0526
		8.3	0.8920	43.0	0.0572
		21.2	0.8775	79.0	0.0625
		30.6	0.8675	123.0	0.0672
		40.0	0.8576	181.1	0.0727
Carbon Tetra-Chloride	(1)	$l_0 = 0.0650$, $l_{20.9} = 0.0794$, $l_{38.8} = 0.0928$, $l_{59.0} = 0.1124$			
	(4)	0°, 1.69 moles H ₂ /atm./gm. solvent 25°, 2.08 " " " " 35°, 2.24 " " " "			
Ethyl Ether	(1)	t^*	l	t^*	l
		-80.6	0.0498	-21.1	0.0964
		-59.9	0.0632	0.0	0.1188
		-40.0	0.0800	+21.1	0.1409
	(6)	$l_0 = 0.1115$, $l_5 = 0.1150$, $l_{10} = 0.1195$, $l_{15} = 0.1259$.			

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS--Contd.
(See p.1088 for list of authors)

Chloro- Benzene	(1)	t°	l	t°	l
		-40.9	0.0303	40.0	0.0702
		-20.5	0.0382	60.3	0.0837
		0.0	0.0479	80.8	0.0976
		+21.2	0.0595		
Methyl Acetate	(1)	-78.5	0.0249	0.0	0.0730
		-60.3	0.0338	+20.9	0.0891
		-40.1	0.0447	40.90	0.1051
		-20.1	0.0578		
Ethyl Acetate	(7)		Density solvent at t°	V.P. Solvent (mm. Hg) at t°	Absorp. Coef. β
		t°			
		0.5	0.9244	25.0	0.0708
		10.0	0.9126	42.7	0.0724
		21.0	0.8993	76.9	0.0761
		30.0	0.8883	118.7	0.0808
		39.8	0.8762	184.0	0.0803
	(2)	$t_{20}^{\circ} = 0.0788, t_{25}^{\circ} = 0.0852$			
Chloroform	(7)		Density solvent at t°	V.P. Solvent (mm. Hg) at t°	Absorp. Coef. β
		t°			
		1.0	1.5260	61.0	0.0563
		10.0	1.5050	100.0	0.0576
		18.7	1.4886	149.6	0.0584
		25.5	1.4750	197.0	0.0614
Dimethyl formamide	(8)	$\beta_{25}^{\circ} = 0.04$			
Toluene	(4)	-15°, 2.51 moles H ₂ /atm./gm. solvent 25°; 3.44 m./atm./gm. 0°, 2.84 " " " 35°; 3.68 " " "			
	(2)	$t_{20}^{\circ} = 0.0838, t_{25}^{\circ} = 0.0874$			
	(25)	Data given from -65° to + 300°, 50-300 atm.			
Carbon disulfide	(4)	-25°, 1.27 moles H ₂ /atm./gm. solvent 0°, 1.66 " " " " +25°, 2.10 " " " "			
	(2)	$t_{20}^{\circ} = 0.0336, t_{25}^{\circ} = 0.0375$			
	(9)	$t_{25}^{\circ} = 0.0607$			
	(10)	Solubility at 25°, 1 atm. is 0.00264 moles per liter.			
Aniline	(2)	$t_{20}^{\circ} = 0.0200, t_{25}^{\circ} = 0.0199$			
Amyl alcohol	(2)	$t_{20}^{\circ} = 0.0353, t_{25}^{\circ} = 0.0301$			
Nitro- benzene	(2)	$t_{20}^{\circ} = 0.0353, t_{25}^{\circ} = 0.0371$			
Amyl acetate	(2)	$t_{20}^{\circ} = 0.0743, t_{25}^{\circ} = 0.0774$			
Isobutanol	(2)	$t_{20}^{\circ} = 0.0929, t_{25}^{\circ} = 0.0976$			
Iso- propanol	(11)	cc H ₂ (25°, 760 mm) dissolved by 1.0 cc of solvent at 25° at various pressures: P atm. 40 60 80 100 150 cc H ₂ 2.5 4.5 6.0 7.5 11.3			

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS--Contd.

(See p.1088 for list of authors)

Propane (11) cc H₂ (25°, 760 mm) dissolved by 1.0 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100
cc H ₂	17.3	25.0	34.0	42.5

n-Butane (12)

t °C	Pressure Atm.	Mole % H ₂ in	
		Liquid	Vapor
23.9	22.2	2.0	83.2
(75°F)	78.6	6.2	-
	103.0	7.4	-
	42.6	4.0	62.7
82.2	60.8	6.3	-
(180°F)	69.0	7.0	-
	93.6	9.9	83.3
	105.8	11.1	-
115.6	38.6	3.2	-
(240°F)	48.9	5.1	42.0
	65.9	7.5	-
	71.0	8.3	-
	91.8	11.1	62.4

(11) cc H₂ (25°, 760 mm) dissolved by 1.0 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100
cc H ₂	11.0	16.5	22.0	27.0

Petane (11) cc H₂ (25°, 760 mm) dissolved by 1.0 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100
cc H ₂	9.0	13.5	18.2	22.5

Hexane (11) cc H₂ (25°, 760 mm) dissolved by 1.0 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100
cc H ₂	5.0	11.0	15.0	18.0

(3) At 35.2°, 140.7 atm., 23.63 cc H₂ dissolve in 1 gm. of solvent.

Cyclohexane(3) At 35.2°, 149.7 atm., 16.53 cc H₂ dissolve in 1 gm. of solvent.

(11) cc H₂ (25°, 760 mm) dissolved by 1 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100	150
cc H ₂	4.0	6.0	8.0	60.0	15.2

(25) Data given from 25-240°, 45-300 atm.

Methyl cyclohexane (25) Data given at 25°, 45-900 atm.

Ethyl

Benzene (25) Data given at 25°, 45-300 atm.

Mesitylene(25) Data given at 25-240°.

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS—Contd.
(See p.1088 for list of authors)

n-Heptane (4)	-30°	4.7	moles H ₂ /atm./gm. solvent
	-25°	4.98	" " "
	-10°	5.51	" " "
	0°	5.89	" " "
	+10°	6.28	" " "
	12.1°	6.35	" " "
	15°	6.46	" " "
	25°	6.87	" " "
	35°	7.28	" " "
	45°	7.70	" " "
	50°	7.91	" " "

- (14) Data for H₂ and D₂. H₂* = data interpolated from ref. 4, above, for comparison.

k = cc gas (S.T.P.) per gm. solvent at 1 atm. pressure
X = mole fraction of hydrogen in the saturated solution.

	25°		37.5°		50°	
	k	X x 10 ⁴	k	X x 10 ⁴	k	X x 10 ⁴
D ₂	0.155	6.94	0.167	7.44	0.177	7.89
H ₂	0.155	6.94	0.167	7.47	0.177	7.89
H ₂ *	0.1542	6.88	0.1657	7.40	0.1774	7.92

n-Perfluoro(4) heptane	-25°	2.59	moles H ₂ /atm./gm. solvent
	0°	3.08	" " "
	+12.1°	3.33	" " "
	25°	3.615	" " "
	35°	3.850	" " "
	50°	4.30	" " "

- (9) $t_{24.8^\circ} = 0.140$, $t_{48.5^\circ} = 0.166$

n-Octane (4)	-25°	4.33	moles H ₂ /atm./gm. solvent
	0	5.14	" " "
	+25°	5.98	" " "
	35°	6.34	" " "

- (14) Data for H₂ and D₂. H₂* = data interpolated from ref. 4, above, for comparison.

k = cc gas (S.T.P.) per gm. solvent at 1 atm. pressure
X = mole fraction of hydrogen in the saturated solution.

	25°		37.5°		50°	
	k	X x 10 ⁴	k	X x 10 ⁴	k	X x 10 ⁴
D ₂	0.133	6.78	0.145	7.38	0.155	7.89
H ₂	0.133	6.77	0.145	7.38	0.155	7.90
H ₂ *	0.1342	6.83	0.1445	7.34	0.1542	7.85

- (11) cc H₂ (25°, 760mm) dissolved by 1 cc of solvent at 25° at various pressures:

P atm.	40	60	80	100	150
cc H ₂	6.0	8.5	11.5	14.9	22.0

H HYDROGEN

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS--Contd. (See p. 1088 for list of authors)

2,2,4-trimethylpentane	(4)	-25°	5.08 moles. H ₂ /atm./gm. solvent
		0°	5.94 " " "
		+25°	6.845 " " "
		35°	7.234 " " "

Xylene	(14)	Total gas Pressure MM.	cc H ₂ (S.T.P.) dissolved by 1 cc solvent				
			-20°	-10°	0°	+20°	+40°
		50	0.006	0.905	-	-	-
		100	0.013	0.011	0.009	0.009	0.010
		200	0.026	0.024	0.018	0.018	0.021
		300	0.039	0.036	0.029	0.029	0.033
		400	0.052	0.048	0.039	0.039	0.044
		500	0.065	0.060	0.046	0.049	0.056
		600	0.078	0.072	0.059	0.059	0.067
		700	0.091	0.084	0.069	0.069	0.078
		760	0.099	0.091	0.075	0.075	0.085

(3) At 35.2°, 150.7 atm. 11.52 cc H₂ dissolve in 1 gm. m-xylene.

(2) $t_{20^\circ} = 0.0783$, $t_{25^\circ} = 0.0819$

(25) Data given from 25°-240°, 50-300 atm.

Petrol (gasoline?)	(14)	Total gas Pressure in mm. Hg.	cc H ₂ (reduced to 0 and 760 mm) dissolved by 1 cc Solvent at:				
			-20°	-10°	0°	+20°	+40°
		50	0.010	0.008	0.007	0.005	0.004
		100	0.019	0.016	0.014	0.010	0.008
		200	0.038	0.034	0.028	0.021	0.017
		300	0.056	0.051	0.043	0.033	0.025
		400	0.074	0.068	0.057	0.044	0.034
		500	0.092	0.085	0.072	0.054	0.042
		600	0.111	0.102	0.087	0.065	0.050
		700	0.129	0.119	0.101	0.076	0.058
		760	0.140	0.129	0.110	0.083	0.064

"Cracking Benzene" (?)	(14)	Total gas Pressure mm.	cc H ₂ (S.T.P.) dissolved by 1 cc solvent				
			-20°	-10°	0°	+20°	+40°
		50	0.014	0.012	0.010	0.008	0.005
		100	0.028	0.022	0.018	0.016	0.010
		200	0.058	0.044	0.036	0.030	0.020
		300	0.087	0.064	0.056	0.044	0.030
		400	0.116	0.084	0.074	0.059	0.040
		500	0.146	0.105	0.094	0.074	0.051
		600	0.175	0.126	0.112	0.088	0.061
		700	0.202	0.148	0.132	0.102	0.072
		760	0.220	0.160	0.144	0.111	0.078

Dichloroethane (14) The data (at 20°) are fairly close to those for "cracking benzene," above.

Cyclohexanol (15) 1 liter of cyclohexanol dissolves 83.1 cc of H₂ at 26°, 760 mm.

SOLUBILITY OF HYDROGEN IN VARIOUS ORGANIC SOLVENTS—Contd.

(See p. 1088 for list of authors)

cc H₂ (measured at 25° and 760mm) dissolved by 1.0 cc
Solvent at:

		40	60	80	100	150	Atmospheres Pressure		
Heavy									
Naphtha	(11)	2.7	4.3	5.6	7.3	10.8			
Gas Oil	(11)	2.5	4.0	5.3	6.8	10.0			
Lard	(16)	40°	5.0 ml. H ₂ (S.T.P.) dissolved in 100 ml. of oil.						
Butter Oil	(16)	40°	5.4		"				
" "	(16)	60°	6.8		"				
Cottonseed									
Oil	(16)	40°	4.7		"				
" "	(17)	22°	4.2		"				
Paraffin									
Oil	(18)	32°	4.		"				
	(19)	Data are given for the solubility of H ₂ and water gas in crude paraffin (m.w. ~ 345) at 93° from 35 to 350 KP/cm ² .							
Russian									
Petroleum	(20)	$\beta_{10} = 0.0652$, $\beta_{20} = 0.0582$							
Polystyrene	(21)	170° P (atm.) of H ₂ : 306.5 243 233 224.5 142 80							
		cc H ₂ (at 0°, 1 atm.) per gm. of							
		Polystyrene : 11.95 9.66 9.42 8.48 5.35 2.89							
		72° P atm. (H ₂) : 186 95							
		cc H ₂ (at 0°, 1 atm.) per gm. of							
		Polystyrene : 11.33 5.63							
Rubber	(22)	The Rubber was made up into cylinders by vulcanization from the following mixture: Rubber (smoked sheet) 100.0 parts by wt., Sulfur 2.5 parts, Zinc Oxide 3.0 parts, Stearic Acid 1.0 parts, Agrite White 0.5 parts, Mercaptobenzthiazole 0.5 parts. The cylinders were 0.447 cm radius x 20 cm long and the circular ends were sealed off with tinfoil. The experiments were carried on in the dark. Using an alternate method of calculation, results smaller than those below by 0.4×10^{-6} were obtained. Results are at one atmosphere pressure.							

t°	cc H ₂ per 100 cc Rubber	Gms. H ₂ Per cc Rubber
21	2.4 (1.0, ref. 23)	-
25	2.6 (4.0, ref. 24)	-
30	-	2.70×10^{-6}
35	-	2.73×10^{-6}
40	-	2.92×10^{-6}

SOLUBILITY OF HYDROGEN IN LIQUID AMMONIA AT SEVERAL
TEMPERATURES AND AT PRESSURES UP TO 1000 ATMOSPHERES
(Wiebe and Tremearne, 1934; Wiebe and Gaddy, 1937)

The steel tube bubbling apparatus previously described for the solubility of H_2 in Water was used. The H_2 contained 0.1% N_2 and the NH_3 contained 0.02% H_2O . No correction was made for these impurities. The values are believed to be accurate to within 2-3 parts per 1000. A nomograph based on these data is given by Davis, 1941a.

Ipatjew, and Theodorowitch, 1932, give results for the solubility of H_2 in liquid NH_3 at 25° and at pressures up to 250 atmospheres which are somewhat lower than these over their whole range.

Total Pressure in Atmospheres	cc H_2 (reduced to 0° and 760 mm) dissolved by 1.0 gm. NH_3 at:				
	0°	25°	50°	75°	100°
25	-	1.695	0.85	-	-
50	3.28	4.47	5.10	3.49	-
75	-	7.20	9.33	9.95	5.80
100	6.70	9.88	13.49	16.35	15.67
150	-	15.08	21.60	29.00	36.35
200	13.11	20.08	29.39	41.41	57.10
300	18.96	29.45	44.42	65.40	98.74
400	24.33	38.13	58.33	88.34	140.60
500	29.27	46.18	71.33	110.22	182.4
600	33.99	53.71	83.48	131.0	224.0
700	38.25	60.77	94.82	150.6	264.3
800	42.33	67.63	105.4	169.2	305.2
900	46.20	73.74	115.3	186.8	346.5
1000	49.77	79.25	124.9	203.3	388.2

SOLUBILITY OF A MIXTURE OF 3 VOLUMES OF HYDROGEN + 1 VOLUME OF NITROGEN
IN LIQUID AMMONIA
(Larson and Black, 1925)

cc gas (at S.T.P.) dissolved by 1.0 gm. liquid ammonia				cc gas (at S.T.P.) dissolved by 1.0 gm. liquid ammonia			
t°	H_2	N_2	Total	t°	H_2	N_2	Total
At total pressure = 50 atm.				At total pressure = 100 atm.--Contd.			
-25.2	1.62	0.73	2.35	-10.0	4.43	1.83	6.26
-18.5	1.90	0.84	2.74	- 5.2	4.84	2.02	6.86
-10.0	2.07	0.94	3.01	0.0	5.28	2.28	7.56
- 3.0	2.35	1.08	3.43	+22.0	7.54	3.21	10.75
0.0	2.61	1.15	3.76	At total pressure = 150 atm.			
+ 2.5	2.70	1.19	3.89	-22.0	4.70	1.89	6.59
+19.0	3.19	1.46	4.65	-17.2	5.12	2.09	7.21
At total pressure = 100 atm.				- 9.2	6.20	2.44	8.64
-25.0	3.30	1.35	4.65	- 7.2	6.30	2.58	8.88
-20.0	3.66	1.46	5.12	+ 5.0	8.22	3.33	11.55
-16.5	3.85	1.63	5.48	+13.3	9.42	3.61	13.03

Results for the system, Hydrogen + Nitrogen + Ammonia (gas) + Ammonia (Liquid) at temperatures from -22.5° to $+18.7^{\circ}$ and pressures from 50 to 1000 atmospheres are given by Larson and Black, 1925. Results for the liquid-vapor equilibrium from 0° - 120° at 10-800 atm. are given by Michels, Skelton and Dumoulin, 1950.

SOLUBILITY OF HYDROGEN - NITROGEN MIXTURES IN LIQUID CARBON DIOXIDE
(Abdulaev, 1941)

t°	Pressure Atm.	% N ₂ in N ₂ + H ₂ Mixture	Mole % H ₂ + N ₂ in		Ml. H ₂ + N ₂ dissolved in 1 gm. Liquid CO ₂
			Liquid	Vapor	
0	51	36	1.87	19.20	9.42
	101	31	7.50	35.10	38.40
	151	28	12.70	50.50	65.70
	200	23	18.80	55.20	98.43
10	65	27	2.80	18.10	14.20
	100	24	9.10	35.15	46.22
	143	23	14.05	39.40	72.63
	167	22	17.12	41.50	88.70
20	203	20	25.50	43.50	135.20
	70	25	2.50	16.10	12.61
	76	23	3.50	19.50	17.72
	82	18	5.30	22.10	27.03
	106	17	13.20	30.20	67.30
	135	15	35.30	35.30	189.00

SOLUBILITY OF HYDROGEN IN MOLTEN NaOH, KOH, AND PYREX GLASS

Melt	Solubility	Author
KOH	Negligible	(Sullivan, Johnson and Banus, 1955)
NaOH	<60 mg/100 g. NaOH at pressures up to 800 p.s.i.	
Pyrex Glass	0.060 ml. (S.T.P.) per gm. glass at 10 mm. pressure	
		(Naughton, 1953)

Liquid-vapor equilibrium data have been determined for the following systems:

H ₂ + N ₂	-165°	10-100 Atm.	(Shtekkel and Tain, 1939)
	-79° to -109°	20-180 Kg/cm ²	(Conikberg, Fastovskii and Gurvich, 193 See also Levitskaya and Pryannikov, 19 and Verschoyle, 1931)
H ₂ + N ₂ + CH ₄ H ₂ + CH ₄	-165°	10-100 Atm.	(Shtekkel and Tain, 1939)
	-165°	10-100 Atm.	(Shtekkel and Tain, 1939)
	-85° to 115°	up to 80 Atm.	(Likhter and Tikhonovich, 1940)
	-183° to -146°	32 to 235 Kg/cm ²	(Fastovskii and Conikberg, 1940)
H ₂ + CH ₄ + C ₂ H ₆ H ₂ + C ₂ H ₆ H ₂ + CH ₄ + C ₂ H ₆ H ₂ + C ₆ H ₆	-183°	17 to 205 Atm.	(Freeth and Verschoyle, 1931)
	-85° to -115°	up to 80 Atm.	(Likhter and Tikhonovich, 1940)
			(Likhter and Tikhonovich, 1939)
			(Levitskaya, 1941)
		up to 3000 Atm.	(Ipatov, Teodorovich, Breatkin, and Artemovich, 1948)
H ₂ + Iso-Butane	100°-250°	500-3000 lbs/sq.in.	(Dean and Tooke, 1946)
H ₂ + 2,2,4 Trimethyl Pentane	100°-302.5°	500-5000	" "
H ₂ + Mixed Isomeric Decane	200°-300°	" "	" "

DATA FOR THE SOLUBILITY OF HYDROGEN IN THE FOLLOWING METALS
HAVE BEEN DETERMINED

Ag	(Steacie and Johnson, 1928; Himmler, 1950 (in alloys with Pd))
Al	(Rontgen and Winterhager (1939); Ransley and Neufeld (liquid and solid)(1948); Baukloh and Oestelen (and some alloys)(1938); Hofman and Maatsch, 1956.)
Ce	(von Samson-Himmelstjerna, 1930)
Co	(Sieverts, 1907; Sieverts and Hagen, 1934)
Cr	(Martin, 1929; Tamman, 1930; Luckemeyer-Hasse and Shenk, 1932)
Cu	(Sieverts, 1911; Miller, 1939; Lieser and Witte, 1954; Himmler, 1950; (in alloys with Zn, Ni, Al, Pt))
Fe	(Sieverts, 1911; Martin, 1929; Sieverts and Hagen, 1931; Luckemeyer-Hasse and Shenk, 1932; Sieverts, Zapf and Moritz, 1938; Armbruster (1943); Sieverts, Zapf, and Moritz (1938)(also D ₂).
Ge	(Hagen and Sieverts, 1930)
In	(" " " ")
La	(von Samson-Himmelstjerna, 1930)
Mg	(Sauerwald (1949)(and in alloys with Al and Zn)(all at 760°); Rontgen and Winterhager 1939; Lieser and Witte (in alloys with Cu, Zn and Ni))
Mn	(Luckemeyer-Hasse and Schenk, 1932; Sieverts and Moritz (1937))
Mo	(Martin, 1929)
Nb	(Hagen and Sieverts, 1930; Sieverts and Moritz (1941)(also D ₂))
Ni	(Sieverts, 1911; Luckemeyer-Hasse and Shenk, 1932; Sieverts and Danz (1941); Armbruster (1943); Hofman and Maatsch, 1956; Lieser and Witte, 1954; Himmler, 1950 (in alloys with Mn, Fe, Si))
Pb	(Hofman and Maatsch, 1956; Opie and Grant, 1951)
Pd	(Sieverts, 1914; von Samson-Himmelstjerna, 1930; Sieverts and Zapf, 1935, also give results for the Solubility of Deuterium; Sieverts and Danz (1937) (and mixtures with D ₂); Owen (1944); Wagner (alloys) (1943); Favreau, Patterson, Randall and Salmon, 1954 (also data for tritium); Perminov, Orlov and Frumkin, 1952; Wagner, 1944.)
Pt	(Sieverts and Jurisch, 1912)
Ti	(Hagen and Sieverts, 1930; Kirschfeld and Sieverts, 1929)
U	(Matraw, 1955)
V	(Kirschfeld and Sieverts, 1929; 1930)
W	(Martin, 1929)
Zr	(Hagg, 1931; Martin and Rees, 1954; Hall, Martin, and Rees (1945))
Zn	(Hofman and Maatsch, 1956)

BORIC ACID H_3BO_3

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For further data see boron trioxide.

SOLUBILITY OF BORIC ACID IN WATER AND IN ORGANIC SOLVENTS
(Semenchenko and Shakparonov, 1948a)

In Water		In 96% Formic Acid		In Glycerin		In Glycol		In Methyl Alcohol		In Acetone		In Isoamyl Alcohol	
%	t°	%	t°	%	t°	%	t°	%	t°	%	t°	%	t°
1	-0.2*	2	6.2	20.2	21	22.2	27.9	19.0	0.6	1.0	8.8	3.7	12
2	-0.4*	2	17.6	23.8	38.0	25.1	41.6	21.0	14.8	1.25	28.3	4.7	23.4
4	13.2	2.5	22.5	27.5	54.5	27.0	50.0	23.0	28.7			5.4	28.6
5	23.1	3	28.2	30.0	63.2							6.0	37.1
6	29.6	3.5	32.9	34.0	71.8							6.4	40.8
7	35.5	4	36.5	38.0	86.7							6.5	41.3

* Solid Phase = Ice

**Solid Phase = Formic Acid

% = Wt. % H_3BO_3 in Solution

t° = Temperature of crystallization of H_3BO_3

Data for the solubility of H_3BO_3 in water from 6°-27° at 0.5° intervals are given by Blesa, 1943.

SOLUBILITY OF BORIC ACID IN SULFURIC ACID SOLUTIONS
(Perova, 1955)

Additional data are given from -46 to +91°, including solutions having Ice and $H_2SO_4 \cdot 4H_2O$ as saturating phases.

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H_3BO_3	H_2SO_4	H_3BO_3	H_2SO_4	H_3BO_3	H_2SO_4
Solid phase H_3BO_3 Throughout					
Results at 0°		Results at 50°		Results at 90°	
2.59	-	10.35	-	23.3	-
1.80	11.3	7.3	10.6	16.8	9.5
1.4	19.3	5.8	18.4	13.0	17.0
0.8	30.8	3.6	29.6	10.0	28.1
0.6	46.2	2.4	45.7	6.4	43.7
0.3	56.2	1.8	55.6	6.0	53.7
Results at 25°		Results at 70°			
5.5	-	15.8	-		
3.6	11.0	11.5	10.1		
2.8	18.8	9.3	17.8		
1.8	30.2	5.9	29.0		
1.2	46.0	3.8	44.7		
0.8	56.0	3.3	54.6		

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ELECTROLYTES
(Constable and Isnel, 1953)

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<u>Potassium Chloride</u>		<u>Ammonium Chloride</u>		<u>Sodium Chloride</u>		<u>Ammonium Acetate</u>		<u>Sodium Carbonate</u>	
Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O	
KCl	H ₃ BO ₃	NH ₄ Cl	H ₃ BO ₃	NaCl	H ₃ BO ₃	NH ₄ OAc	H ₃ BO ₃	Na ₂ CO ₃	H ₃ BO ₃
<u>At 14°</u>		<u>At 14°</u>		<u>At 14°</u>		<u>At 25°</u>		<u>At 25°</u>	
24.0	4.3	19.0	4.0	27.0	4.0	12.0	5.0	1.0	5.0
36.0	5.0	39.0	5.0			16.0	6.0	4.0	10.0
<u>At 25°</u>		<u>At 25°</u>		<u>At 25°</u>		18.0	6.4	9.0	20.0
15.0	5.0	25.0	5.0	12.0	4.8	24.0	7.8	10.0	23.0
30.0	6.0	35.0	5.4	37.0	5.6	30.0	9.0	14.0	27.0
40.0	6.6	45.0	6.0	<u>At 32°</u>		42.0	10.0	17.0	33.0
<u>At 32°</u>		<u>At 32°</u>		10.0	6.0	<u>At 32°</u>		23.0	38.0
7.5	6.0	20.0	6.0	20.0	7.0	10.0	6.8	<u>At 32°</u>	
15.0	6.7	40.0	7.0	<u>At 40°</u>		18.0	8.0	1.0	6.0
20.0	7.2	50.0	8.0	15.0	8.0	20.0	8.2	4.0	12.0
30.0	7.3	<u>At 40°</u>		30.0	8.5	22.0	9.0	6.0	16.0
40.0	7.3	30.0	8.8	<u>At 60°</u>		26.0	9.8	8.0	22.0
<u>At 40°</u>		40.0	9.4	4.0	12.0	36.0	11.0	11.0	27.0
15.0	8.4	50.0	10.0	8.0	12.5	<u>At 40°</u>		14.0	31.0
22.5	9.0	<u>At 60°</u>		15.0	13.0	11.0	8.4	17.0	41.0
35.0	9.8	20.0	12.0	35.0	14.0	15.0	9.0	23.0	46.0
40.0	10.0	30.0	13.0	<u>At 80°</u>		21.0	10.0	27.0	54.0
<u>At 60°</u>		40.0	14.0	2.0	18.0	25.0	11.0	<u>At 40°</u>	
4.0	12.0	50.0	15.0	6.0	19.2	31.0	14.0	1.0	8.0
9.0	13.0	60.0	16.0	10.0	20.0	36.0	16.0	4.0	15.0
16.0	14.0	65.0	17.0	16.0	21.0	<u>At 60°</u>		9.0	25.0
23.0	15.0	<u>At 80°</u>		<u>At 100°</u>		0.5	12.0	15.0	36.0
35.0	16.0	25.0	18.0	1.0	31.5	2.0	15.0	21.0	48.0
45.0	17.0	35.0	19.0	3.0	34.7	5.0	20.0	28.0	63.0
<u>At 80°</u>		45.0	20.0	4.0	35.8	7.0	22.0	34.0	73.0
4.0	18.0	55.0	21.0	5.0	37.0	9.0	24.0	<u>At 60°</u>	
9.0	19.2	65.0	22.0	10.0	40.0	11.0	25.0	1.0	12.0
13.0	20.0	<u>At 100°</u>		25.0	42.0	15.0	28.0	7.0	22.0
20.0	21.2	5.0	30.4	<u>At 80°</u>		17.0	29.0	11.0	32.0
30.0	22.0	10.0	31.6	0.2	18.0	<u>At 100°</u>		21.0	52.0
<u>At 100°</u>		15.0	32.6	2.0	26.0	6.0	34.0	31.0	72.0
0.5	30.0	25.0	33.0	4.0	30.0	9.0	39.0	45.0	92.0
5.0	35.0	30.0	35.0	6.0	34.0	10.0	40.0	65.0	112.0
7.5	36.8	45.0	37.0	9.0	39.0	13.0	44.0	70.0	132.0
10.0	38.4	55.0	42.0	10.0	40.0	<u>At 80°</u>		<u>At 80°</u>	
12.5	39.6	85.0	47.0	13.0	44.0	1.0	32.2	1.0	18.0
15.0	40.8	<u>At 100°</u>		16.0	63.0	2.0	34.0	4.0	28.0
20.0	42.6	5.0	30.4	1.0	31.5	4.0	38.4	14.0	48.0
30.0	44.6	10.0	31.6	2.0	34.7	6.0	45.0	26.0	70.0
<u>At 100°</u>		15.0	32.6	4.0	35.8	9.0	51.0	38.0	92.0
0.5	30.0	25.0	33.0	6.0	37.0	10.0	53.0	50.0	114.0
5.0	35.0	30.0	35.0	9.0	40.0	11.0	55.0	55.0	122.0
7.5	36.8	45.0	37.0	10.0	42.0	12.0	59.0	63.0	138.0
10.0	38.4	55.0	42.0	13.0	44.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	<u>At 100°</u>		<u>At 80°</u>		1.0	32.2	1.0	32.0
15.0	40.8	5.0	30.4	0.2	18.0	2.0	34.0	4.0	40.0
20.0	42.6	10.0	31.6	4.0	30.0	4.0	38.4	6.0	48.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	6.0	45.0	14.0	68.0
0.5	30.0	25.0	33.0	9.0	39.0	9.0	51.0	22.0	88.0
5.0	35.0	30.0	35.0	10.0	40.0	10.0	53.0	32.0	108.0
7.5	36.8	45.0	37.0	13.0	44.0	11.0	55.0	46.0	138.0
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		62.0	168.0
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	<u>At 100°</u>	
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	1.0	32.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	6.0	48.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	14.0	68.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	22.0	88.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	32.0	108.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	46.0	138.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	62.0	168.0
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0
0.5	30.0	25.0	33.0	9.0	39.0	11.0	55.0	46.0	138.0
5.0	35.0	30.0	35.0	10.0	40.0	12.0	59.0	62.0	168.0
7.5	36.8	45.0	37.0	13.0	44.0	14.0	63.0	<u>At 100°</u>	
10.0	38.4	55.0	42.0	16.0	63.0	<u>At 100°</u>		<u>At 100°</u>	
12.5	39.6	85.0	47.0	<u>At 100°</u>		2.0	26.0	1.0	32.0
15.0	40.8	<u>At 100°</u>		<u>At 80°</u>		4.0	38.4	6.0	48.0
20.0	42.6	5.0	30.4	0.2	18.0	6.0	45.0	14.0	68.0
30.0	44.6	10.0	31.6	4.0	30.0	9.0	51.0	22.0	88.0
<u>At 100°</u>		15.0	32.6	6.0	34.0	10.0	53.0	32.0	108.0

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ELECTROLYTES--Contd.

<u>K₂SO₄</u>		<u>Na₂SO₄</u>		<u>NaH₂PO₄</u>		<u>CuSO₄</u>		<u>NaSO₄</u>	
Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O	
<u>K₂SO₄</u>	<u>H₃BO₃</u>	<u>Na₂SO₄</u>	<u>H₃BO₃</u>	<u>NaH₂PO₄</u>	<u>H₃BO₃</u>	<u>CuSO₄</u>	<u>H₃BO₃</u>	<u>NaSO₄</u>	<u>H₃BO₃</u>
<u>At 14°</u>		<u>At 12°</u>		<u>At 25°</u>		<u>At 14°</u>		<u>At 14°</u>	
3.0	5.0	4.0	3.0	4.0	5.0	10.0	4.0	10.0	4.0
5.0	6.0	15.0	4.0	10.0	6.0	20.0	5.0	24.0	5.0
<u>At 25°</u>		<u>At 24°</u>		<u>At 32°</u>		<u>At 25°</u>		<u>At 25°</u>	
2.0	5.2	10.0	5.0	4.0	6.0	7.0	4.8	10.0	4.8
4.0	7.0	22.0	6.2	12.0	7.0	22.0	5.7	28.0	6.0
<u>At 32°</u>		<u>At 32°</u>		<u>At 40°</u>		<u>At 32°</u>		<u>At 32°</u>	
1.0	6.0	26.0	6.5	28.0	10.4	10.0	6.8	2.0	5.8
2.0	7.0	<u>At 32°</u>		<u>At 40°</u>		27.0	7.95	18.0	6.8
3.0	8.0	11.0	6.6	10.0	9.0	<u>At 40°</u>		38.0	8.0
<u>At 40°</u>		21.0	7.8	18.0	10.5	6.0	8.0	12.0	8.0
1.0	8.0	31.0	8.8	30.0	13.0	16.0	9.0	25.0	9.0
2.0	9.0	41.0	9.8	46.0	16.0	<u>At 60°</u>		37.0	9.2
3.0	10.0	<u>At 40°</u>		<u>At 60°</u>		28.0	15.0	65.0	17.0
<u>At 60°</u>		5.0	8.0	5.0	12.0	4.0	12.0	<u>At 60°</u>	
1.0	17.0	13.0	9.0	7.0	12.5	10.0	13.0	5.0	12.6
2.0	15.0	24.0	10.0	15.0	14.0	18.0	14.0	10.0	13.1
3.0	16.0	40.0	11.0	23.0	15.5	28.0	15.0	15.0	13.8
4.0	16.5	<u>At 60°</u>		35.0	17.8	<u>At 80°</u>		32.0	15.0
<u>At 80°</u>		3.0	13.0	50.0	20.5	3.0	18.0	62.0	16.0
1.0	19.0	5.0	14.0	65.0	23.4	6.0	19.0	<u>At 80°</u>	
2.0	21.0	9.0	15.3	<u>At 80°</u>		14.0	20.7	4.0	18.0
3.0	22.5	13.0	16.0	4.0	18.0	16.0	21.0	9.0	19.0
4.0	23.4	<u>At 80°</u>		12.0	19.4	18.0	22.0	18.0	21.2
<u>At 100°</u>		3.0	20.0	18.0	20.4	28.0	23.0	30.0	23.5
1.0	31.0	5.0	21.2	22.0	21.0	<u>At 100°</u>		50.0	26.4
2.0	33.0	7.0	22.0	34.0	22.0	2.0	31.2	65.0	28.2
3.0	33.8	<u>At 100°</u>		44.0	23.0	6.0	34.4	<u>At 100°</u>	
4.0	34.2	2.0	37.0	54.0	24.0	10.0	37.1	2.5	33.0
5.0	34.3	4.0	42.0	<u>At 100°</u>		12.0	38.4	5.0	36.0
<u>At 100°</u>		8.0	49.5	5.0	30.6	18.0	41.9	7.0	38.0
1.0	31.0	12.0	55.0	10.0	31.6	20.0	42.8	11.5	42.0
2.0	33.0	16.0	59.5	15.0	32.6	22.0	44.0	15.0	44.6
3.0	33.8	20.0	62.5	27.0	34.0	44.0	59.0	25.0	50.8
4.0	34.2	24.0	65.0	52.0	36.0	44.0	56.0	35.0	56.0
5.0	34.3	<u>At 100°</u>		62.0	38.0	44.0	59.0	40.0	58.0
<u>At 100°</u>		<u>At 100°</u>		<u>At 100°</u>		<u>At 100°</u>		44.0	59.0

<u>ZnSO₄</u>		<u>FeCl₃</u>		<u>AlCl₃</u>		<u>HCl, HNO₃ or H₂SO₄ (?)</u>	
Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 Gms. H ₂ O		Gms. per 100 Gms. H ₂ O	
<u>ZnSO₄</u>	<u>H₃BO₃</u>	<u>FeCl₃</u>	<u>H₃BO₃</u>	<u>AlCl₃</u>	<u>H₃BO₃</u>	<u>Acid</u>	<u>H₃BO₃</u>
<u>At 25°</u>		<u>At 14°</u>		<u>At 16°</u>		<u>At 14°</u>	
3.0	5.0	30.0	4.0	46.0	4.0	62.0	4.0
6.0	6.0	<u>At 25°</u>		<u>At 25°</u>		<u>At 25°</u>	
<u>At 32°</u>		55.0	5.0	40.0	5.0	62.0	5.0
3.0	6.0	<u>At 32°</u>		<u>At 32°</u>		<u>At 32°</u>	
6.0	7.0	90.0	6.0	22.0	6.0	62.0	6.0
<u>At 40°</u>		<u>At 40°</u>		<u>At 40°</u>		<u>At 40°</u>	
8.0	7.0	40.0	8.0	20.0	8.0	62.0	8.0
<u>At 60°</u>		<u>At 60°</u>		<u>At 60°</u>		<u>At 60°</u>	
5.0	12.0	30.0	12.0	20.0	12.0	62.0	12.0
9.0	13.0	40.0	13.0	<u>At 80°</u>		<u>At 80°</u>	
10.0	14.0	<u>At 80°</u>		10.0	16.0	62.0	28.0
<u>At 80°</u>		2.0	18.0	<u>At 100°</u>		<u>At 100°</u>	
4.0	20.0	30.0	19.0	20.0	30.0	62.0	30.0
<u>At 100°</u>		<u>At 100°</u>		<u>At 100°</u>		<u>At 100°</u>	
1.0	30.0	10.0	30.5	<u>At 100°</u>		<u>At 100°</u>	
2.0	31.0	15.0	31.0	20.0	30.0	<u>At 100°</u>	
3.0	32.0	25.0	32.0	<u>At 100°</u>		<u>At 100°</u>	

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ELECTROLYTES--Contd.

$(\text{NH}_4)_2\text{HPO}_4$		Na_2HPO_4		$\text{NH}_4\text{H}_2\text{PO}_4$		NaHCO_3		$(\text{NH}_4)_2\text{SO}_4$	
Gms. per 100 gms. H_2O		Gms. per 100 gms. H_2O		Gms. per 100 gms. H_2O		Gms. per 100 gms. H_2O		Gms. per 100 gms. H_2O	
$(\text{NH}_4)_2\text{P}$	H_3BO_3	Na_2P	H_3BO_3	NH_4P	H_3BO_3	NaHCO_3	H_3BO_3	$(\text{NH}_4)_2\text{SO}_4$	H_3BO_3
At 25°		At 25°		At 25°		At 25°		At 14°	
5.0	7.0	4.0	5.4	7.0	5.0	2.0	8.0	11.0	4.0
6.0	7.4	5.0	6.0	22.0	6.4	3.0	10.0	26.0	5.0
7.0	8.2	6.0	6.6	27.0	7.0	5.0	15.0	41.0	6.0
9.0	9.4	8.0	7.4			7.0	20.0		
10.0	10.0	12.0	9.0	At 32°		9.0	25.0	At 25°	
15.0	13.0	16.0	10.6			14.0	35.0		
19.0	16.0	19.0	12.0	12.0	6.0	18.0	44.0	30.0	5.0
At 32°		23.0	13.6	24.0	7.0			40.0	7.0
1.0	6.0			39.0	8.0	At 32°		50.0	8.0
2.0	7.2	At 32°		At 40°		1.0	8.0	At 32°	
4.0	8.8	2.0	7.0			3.0	14.0		
7.0	11.8	5.0	9.0	20.0	8.0	7.0	26.0	35.0	7.8
11.0	16.0	11.0	12.0	30.0	9.0	11.0	36.0	45.0	8.1
14.0	18.0	18.0	16.0	45.0	10.0	14.0	44.0	55.0	8.8
At 40°		33.0	24.4	55.0	11.0	20.0	56.0	75.0	10.0
		35.0	26.0					85.0	10.5
		39.0	28.0						
2.0	8.0	At 40°		At 60°		At 40°		At 40°	
3.0	10.0			15.0	12.4	5.0	22.0		
5.0	12.0	2.0	8.0	20.0	13.0	8.0	30.0		
8.0	15.0	10.0	13.0	35.0	14.0	11.0	38.8	25.0	8.0
12.0	18.0	14.0	15.6	45.0	15.0	13.0	48.0	40.0	9.0
13.0	20.0	22.0	20.0	60.0	16.0	18.0	58.0	60.0	10.0
15.0	22.0	34.0	27.0	70.0	17.0	23.0	70.0	80.0	11.0
At 60°		44.0	32.5						
		50.0	36.0						
1.0	12.0	At 60°		At 80°		At 60°		At 60°	
2.0	14.0			5.0	19.0	4.0	22.0	25.0	13.0
4.0	16.0	4.0	13.8	7.0	20.0	6.0	29.0	35.0	13.8
8.0	20.0	9.0	17.0	9.0	20.6	10.0	42.0	45.0	14.5
12.0	24.0	16.0	21.8	11.0	21.0	15.0	56.0	55.0	15.2
13.0	26.0	34.0	33.0	19.0	22.0	19.0	68.0	65.0	16.2
14.0	28.0	74.0	56.4	25.0	23.0	21.0	72.0	85.0	18.0
At 80°		94.4	67.0			23.0	82.0		
1.0	18.0	At 80°		At 100°		At 80°		At 80°	
3.0	22.0	3.0	19.0	10.0	31.6	2.0	28.0	5.0	18.0
7.0	28.0	13.0	25.4	15.0	32.4	6.0	48.0	15.0	20.0
9.0	31.0	28.0	35.4	20.0	33.0	12.0	68.0	25.0	21.0
11.0	34.0	43.0	45.0	25.0	33.4	18.0	84.0	35.0	22.0
13.0	38.0	73.0	63.8	30.0	34.0	24.0	96.0	55.0	23.0
At 100°		88.0	73.0	40.0	35.0			65.0	23.2
				55.0	37.0	At 100°		70.0	23.8
1.0	30.0	At 100°		75.0	39.0				
4.0	34.0	0.8	30.0	85.0	40.0	3.0	58.0	At 100°	
8.0	38.0	16.8	40.0			5.0	68.0	10.0	30.8
11.0	42.0	32.8	50.0			8.0	78.0	15.0	31.0
14.0	45.0	48.0	61.0			11.0	88.0	25.0	32.0
16.0	48.0	63.0	70.0			15.0	98.0	40.0	33.0
19.0	50.0	73.0	80.0			19.0	108.0	65.0	35.0
21.0	53.0							75.0	35.8
23.0	55.0							85.0	36.0
25.0	58.0							105.0	37.0
27.0	60.0								

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ELECTROLYTES—Contd.

Zinc Acetate		Acetic Acid		Ammonia		Aniline	
Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O		Gms. per 100 gms. H ₂ O	
Zn(OAc) ₂	H ₃ BO ₃	HOAc	H ₃ BO ₃	NH ₃	H ₃ BO ₃	C ₆ H ₅ NH ₂	H ₃ BO ₃
<u>At 25°</u>		<u>At 25°</u>		<u>At 25°</u>		<u>At 25°</u>	
1.0	5.0	3.2	4.8	0.3	5.0	1.8	5.0
2.0	6.0	11.1	6.0	1.0	6.0	2.6	5.8
				1.4	7.0	5.0	7.0
<u>At 32°</u>		<u>At 32°</u>		<u>At 32°</u>		<u>At 32°</u>	
2.0	6.6	3.4	6.6	3.2	11.0	1.5	6.0
3.0	7.0	5.6	7.0	5.0	15.0	2.0	7.0
4.0	8.0	11.0	8.0	7.0	19.0	3.4	8.0
6.0	9.0			9.0	23.0	6.0	9.4
				13.6	28.0		
<u>At 40°</u>		<u>At 40°</u>		<u>At 32°</u>		<u>At 40°</u>	
1.0	8.0	4.8	8.0	0.2	6.0	1.5	8.0
2.0	9.0	9.0	9.0	1.0	8.0	1.8	9.0
3.0	10.0	13.0	10.0	3.4	15.0	3.0	10.0
				8.0	25.0	4.4	11.0
<u>At 60°</u>		<u>At 60°</u>		<u>At 32°</u>		<u>At 60°</u>	
1.0	13.4	4.0	12.0	15.5	35.0	1.0	12.0
2.0	15.0	8.0	13.0	24.6	45.0	1.8	13.0
4.0	16.0	16.0	15.0	31.7	50.0	2.8	14.0
		21.0	16.0	<u>At 40°</u>		4.0	15.0
<u>At 80°</u>		<u>At 80°</u>		0.2	8.0	6.4	16.0
0.2	18.0			2.6	13.0	7.0	17.0
2.0	23.0	4.3	18.0	7.1	23.0	8.5	18.0
3.0	25.0	5.2	19.0	12.5	33.0		
4.0	27.0	9.0	20.0	18.4	43.0	<u>At 80°</u>	
6.0	29.4	12.5	21.0	26.1	53.0	1.3	18.0
		15.0	22.0	34.8	63.0	2.4	19.6
<u>At 100°</u>		19.0	23.0	40.1	68.0	3.4	20.6
0.2	30.0	<u>At 100°</u>		<u>At 60°</u>		3.8	21.0
2.0	34.0			0.5	12.0	5.2	22.6
3.0	36.0	2.0	30.0	8.3	32.0	5.7	23.0
4.0	38.0	10.0	32.0	18.9	52.0	6.6	24.0
5.0	40.0	16.3	33.0	28.5	72.0	7.7	25.0
		18.2	34.0	37.4	87.0	10.5	26.8
		22.4	35.0	42.0	92.0	11.2	27.0
				48.9	97.0		
				54.9	102.0		
				<u>At 80°</u>		<u>At 100°</u>	
				1.1	18.0	0.8	30.4
				3.8	28.0	2.8	33.0
				11.8	48.0	3.8	34.0
				22.0	68.0	5.6	36.0
				33.9	88.0	8.2	38.6
				52.9	108.0	9.6	40.0
				<u>At 100°</u>		14.5	42.8
				1.2	30.0	18.1	54.0
				4.3	40.0		
				7.6	50.0		
				11.1	60.0		
				15.6	70.0		
				20.5	80.0		
				26.8	100.0		

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H HYDROGEN

Br HYDROGEN BROMIDE HBr

SOLUBILITY IN WATER

(Roozeboom, 1885, 1886, 1888; see also Pickering, 1893)

β = Bunsen Absorption Coefficient which is the volume of gas (reduced to 0 and 760 mm) absorbed by 1 volume of the liquid when the pressure of the gas itself, without the tension of the liquid, amounts to 760 mm.

t°	Gms. HBr Dissolved (at 760-765 mm) per 100 Gms.		β	Gms. HBr Dissolved at Lower pressures per 100 Gms. H ₂ O
	Water	Solution		
- 2.5	255.0	71.83	...	175.0 (10 mm.)
-15	239.0	70.50	...	...
0	221.2	68.85	611.6	...
+10	210.3	67.76	581.4	108.5 (5 mm.)
15	204.0	67.10	...	...
25	193.0	65.88	532.1	(See Table Below)
50	171.5	63.16	468.6	...
75	150.5	60.08	406.7	...
100	130.0	56.52	344.6	...

SOLUBILITY OF HYDROGEN BROMIDE IN WATER AT 25° AT LOW PRESSURES (Bates and Kirschman, 1919)

Partial Pressure HBr in mm.	Moles HBr Dissolved per 1000 gms. H ₂ O	Partial pressure HBr in mm.**	Moles HBr Dissolved per 1000 gms. H ₂ O
0.00151	6.0	0.0226	9.0
.00370	7.0	.059	10.0
.0089	8.0	.151	11.0

FREEZING-POINTS OF DILUTE AQUEOUS HYDROBROMIC ACID SOLUTIONS (Klein and Svanberg, 1920)

t° of F. pt.	Normality of Aq. HBr
-0.362	0.1
-0.923	0.25
-1.907.	0.5

EQUILIBRIUM IN THE SYSTEM HYDROBROMIC ACID, WATER AND ALCOHOLS AT 25° (Reburn and Shearer, 1933)

The determinations were made by adding from a buret one of the constituents to known mixtures of the other two until appearance of permanent turbidity. The tie lines of the saturation curve thus obtained were determined by mixing suitable amounts of the three constituents to yield two liquid layers at 25° and titrating each of these for HBr content.

Results for
HBr + H₂O + Iso Amyl Alcohol
(CH₃)₂CHCH₂CH₂OH

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H ₂ O	C ₅ H ₁₂ O	H ₂ O	C ₅ H ₁₂ O
9.0	91.0	42.0	25.0
11.36	85.3	45.8	19.1
16.90	76.8	54.7	8.17
17.7	70.6	67.7	3.39
21.2	63.2	76.9	3.00
26.4	57.6	83.0	2.84
28.4	47.8	91.7	2.58
30.2	44.2	97.0	3.00

Results for
HBr + H₂O + Iso Butyl Alcohol,
(CH₃)₂CHCH₂CH₃

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H ₂ O	C ₄ H ₁₀ O	H ₂ O	C ₄ H ₁₀ O
16.1	83.9	62.4	20.0
22.6	72.7	66.9	15.4
29.1	61.8	70.8	12.6
35.1	53.1	75.5	11.0
48.9	35.0	82.8	8.7
57.3	25.7	91.2	8.8

8r

Tie Line Data

Tie Line Data

Gms. HBr per 100 gms.

Gms. HBr per 100 gms.

H ₂ O layer	C ₅ H ₁₂ O layer
13.5	3.5
24.0	13.0
34.1	23.5

H ₂ O layer	C ₄ H ₁₀ O layer
10.8	6.0
8.7	4.3

THE SYSTEM HBr - 1,4 DIOXANE - WATER AT 25°
(Grubb and Osthoff, 1952)

Addition of HBr aq. to dioxane causes the formation of two liquid phases. 25 ml of dioxane was used in each case. A = point of phase separation. B = composition at disappearance of 2nd phase.

Aq. HBr added		Wt. % in Solution		Aq. HBr added		Wt. % in Solution	
ml	Normality	H ₂ O	HBr	ml	Normality	H ₂ O	HBr
A 0.71	14.70	1.58	3.15	A 0.65	4.34	2.19	0.86
B 3.78	14.70	6.99	13.93	B 3.57	4.34	10.57	4.15
A 0.60	13.85	1.41	2.52	A 1.66	3.69	5.46	1.74
B 4.49	13.85	8.42	15.04	B 7.20	7.75	16.05	12.59
A 0.48	11.97	1.24	1.76	A 0.84	3.64	2.86	0.93
B 5.85	11.97	11.34	16.06	B 7.02	8.37	15.35	13.25
A 0.43	10.70	1.18	1.41	A 1.28	3.40	4.31	1.29
B 6.49	10.70	13.04	15.62	B 2.72	4.02	8.43	3.07
A 0.46	8.99	1.35	1.28	A 5.22	5.00	14.11	6.48
B 6.95	8.99	14.82	14.07	B 2.12	3.64	6.82	2.25
A 0.44	7.59	1.34	1.02			2.46	5.59*
B 7.08	7.59	16.00	12.17			3.55	7.91*
A 0.48	6.20	1.53	0.91			4.56	10.13*
B 6.54	6.20	16.01	9.52			5.52	11.76*
						6.44	3.19*
						8.22	14.88*

*Gaseous hydrogen bromide added to attain these concentrations.

DISTRIBUTION OF HBr BETWEEN WATER AND ETHERS

(Results of Bock, Kusche, and Bock, 1953)
at 20°

100 ml aq. acid + 100 ml ethyl ether were used.

Molarity aq. HBr	Volume after partition		Conc. in org. phase
	ml (C ₂ H ₅) ₂ O	ml H ₂ O	Conc. in aq. phase
1.0	88	110	0.00016
2.0	86	113	0.0003
3.0	85	114	0.0003
4.0	72	125	0.0006
5.0	55	140	0.0013
6.0	27	166	0.0017

(Results of Chalkey and Williams, 1955)
at room temperature

Ethyl Ether		Isopropyl Ether	
Molarity aq. HBr	Molarity HBr in ether layer	Molarity aq. HBr	Molarity HBr in ether layer
1.38	0.00010	2.80	0.00010
1.73	0.00016	3.16	0.00012
2.07	0.00026	3.45	0.00015
2.41	0.00040	3.70	0.00020
2.75	0.00052	4.30	0.00035
3.15	0.00068	5.00	0.00050
3.70	0.00123	5.65	0.00064

SOLUBILITY OF HBr IN ORGANIC SOLVENTS

Solvent	t°	Solubility and Reference
Chloroform	0	0.0754 = mole fraction HBr in sat. sol. at 1 atm. partial pressure
	15	.0545 = " " "
	25	.0454 = " " "
		(Howland, Miller and Willard, 1941)
Carbon tetrachloride	0	0.0628 = mole fraction HBr in sat. sol. at 1 atm. partial pressure
	15	.0452 = " " "
	25	.0382 = " " "
		(Howland, Miller and Willard, 1941)
Benzene	5.7	Henry's law constant = 5920 (in millimeters)
		(Brown and Wallace, 1953)
	30-50	The solubility of HBr in benzene from 8 to 630 mm. pressure and 30° to 50° has been determined by Kapustinski and Maltsev, 1940. At 30° the Henry's law constant is 15.8 ± .5 from 0.01 to 0.74 atm. partial pressure of HBr.

SOLUBILITY OF HBr IN ORGANIC SOLVENTS--Contd.

Solvent	t°	Solubility and Reference			
Toluene	0	Henry's law constant =	4440 (in mm.)	(Brown and Wallace, 1953)	
	-78.5	" " "	= 100 (in mm.)	(" " " ")	
m-Xylene	0	" " "	= 3730 (in mm.)	(" " " ")	
Mesitylene	0	" " "	= 3370 (in mm.)	(" " " ")	
Dimethyl formamide	0	680 ml. (S.T.P.) HBr per ml DMF at partial pressure HBr = 1 atm. (Du Pont, 1955)			
n-Butane	5	Henry's law constant =	326 (P.S.I.-mole fraction HBr)		
	25	" " "	= 443 (" " ")		
			(Fontana and Herold, 1948)		
n-Hexane	5	" " "	= 265 (P.S.I.-mole fraction HBr)		
	20	" " "	= 348 (" " ")		
			(Fontana and Herold, 1948)		
	35	" " "	= 1900 (mm HBr/mole HBr per 1000 gm. sol.)		
	45	" " "	= 2150 (" " ")		
			(Boedecker and Lynch, 1950)		
n-Octane	25	" " "	= 2000 (mm HBr/mole HBr per 1000 gm. sol.)		
	35	" " "	= 2300 (" " ")		
	45	" " "	= 2650 (" " ")		
			(Boedecker and Lynch, 1950)		
n-Decane	25	" " "	= 2100 (mm HBr/mole HBr per 1000 gm. sol.)		
	35	" " "	= 2450 (" " ")		
	45	" " "	= 2800 (" " ")		
			(Boedecker and Lynch, 1950)		

Data for the solubility of HBr in solutions of $AlBr_3$ + benzene, toluene, m-xylene, and mesitylene are given by Brown and Wallace, 1953. For data in $AlBr_3$ + n-butane solutions see Boedecker and Lynch, 1950.

Freezing-point data are given for mixtures of HBr and each of the following compounds.

CH_3OH	(1)	C_3H_4	(4)	$C_6H_5C_3H_7$	(5)
C_2H_5OH	(1)	CH_3COCH_3	(1)	C_7H_4	(5)
CH_3C	(2)	$CH_3COOC_2H_5$	(1)	$C_6H_4(CH_3)_2O \approx R$	(5)
$CHCl_3$	(1)	C_6H_6	(1)	C_9H_{12}	(2)
$(CH_3)_2O$	(1)	$C_6H_5CH_3$	(1)(2)	H_2S	(6)
CH_3Cl	(1)	$C_6H_3(CH_3)_3(s)$	(2)	DBr	(7)
$(C_2H_5)_2O$	(3)	$C_6H_5C_2H_5$	(2)		

(1) = Maass and McIntosh, 1912; Reid and McIntosh, 1916;

(2) = Maass and Russell, 1918

(3) = McIntosh, 1911

(4) = Maass and Russell, 1921;

(5) = Maass, Boomer and Morrison, 1923

(6) = Bagster, 1911

(7) = Clusius, 1946

N HYDROGEN

CN HYDROGEN CYANIDE HCN (Hydrocyanic Acid)

SOLUBILITY IN WATER
(Horiuchi and Tanabe, 1951)

$$[l = [\text{HCN}] \text{ liquid} / [\text{HCN}] \text{ vapor}]$$

t°	Ostwald Soly. coef. l	t°	Ostwald Soly. coef. l	t°	Ostwald Soly. coef. l
0.0	482	20.2	238	50.0	88
10.7	330	30.2	172	60.0	69
18.1	252	40.2	125	70.0	57

FREEZING-POINTS OF MIXTURES OF HYDROGEN CYANIDE AND WATER (Coates and Hartshorne, 1931)

The apparatus was provided with a magnetically operated stirrer. A mercury thermometer was used and the freezing-points determined by back extrapolation of time-temperature curves over the super cooling region except near the eutectic point. Here it was necessary to employ a jet of air directed a short distance above the level of the liquid. The rapid evaporation thus induced caused crystals to form which inoculated the mixture and prevented super cooling. The mixtures of which the freezing-points were determined were analyzed by Liebig's method of silver nitrate titration. The results in the metastable region were obtained by a modified form of apparatus in which stirring was avoided and a rapid rate of cooling was employed.

Gm. Mols. HCN per 100 gm. Mols. Solid			Gm. Mols. HCN per 100 gm. Mols. Solid			Gm. Mols. HCN per 100 gm. Mols. Solid		
t°	HCN + H ₂ O	Phase	t°	HCN + H ₂ O	Phase	t°	HCN + H ₂ O	Phase
- 0.9	0.81	Ice	-16.4	50.29	Ice	-15.8	95.9	HCN
- 3.5	3.09	"	-17.3	59.24	"	-14.4	98.5	"
- 7.7	7.76	"	-19.3	66.96	"	-13.3	100.0	"
- 9.9	9.89	"	-21.1	70.4	"	-24.7	24.8*	
-12.8	14.25	"	-22.6	73.0	"	-24.0	34.4*	
-14.45	19.36	"	-23.4	74.5	" + HCN	-24.1	39.2*	
-15.5	26.29	"	-22.5	79.7	HCN	-24.5	47.9*	
-16.0	36.82	"	-19.4	88.9	"	-25.6	54.7*	
						-27.5	58.7*	

- *Metastable region - consisting of two liquid phases with critical solution temp. of -24.0°.

Additional determinations in agreement with the above are given by Peiker and Coffin, 1933. These investigators also give results for the f. pts. of mixtures of HCN + HCOOH, HCN + HCONH₂ and HCN + C₆H₅CHO.

DISTRIBUTION BETWEEN WATER AND BENZENE
(Hantzsch and Sebal, 1899; Hantzsch and Vagt, 1901)

Mol. HCN per Liter				Mol. HCN per Liter			
t°	H ₂ O Layer (c)	C ₆ H ₆ Layer (c')	$\frac{c}{c'}$	t°	H ₂ O Layer (c)	C ₆ H ₆ Layer (c')	$\frac{c}{c'}$
6	0.00625	0.00325	1.923	7	0.0574	0.0148	3.88
16	0.00593	0.00363	1.634	20	0.0572	0.0154	3.72
25	0.00580	0.00375	1.547				

Data for the effect of HCl and KCl on the distribution are also given.

DISTRIBUTION OF HYDROGEN CYANIDE BETWEEN WATER AND BENZENE
(Gross and Schwarz, 1930)

Gm. Mols. HCN per 1000 cc			Gm. Mols. HCN per 1000 cc			Gm. Mols. HCN per 1000 cc		
t°	H ₂ O layer	C ₆ H ₆ layer	t°	H ₂ O layer	C ₆ H ₆ layer	t°	H ₂ O layer	C ₆ H ₆ layer
15	0.01084	0.002665	15	0.3494	0.0905	15	0.5532	0.1486
"	0.02167	0.005342	"	0.3777	0.0981	"	0.6507	0.1772
"	0.04334	0.01073	"	0.3999	0.1051	"	0.9178	0.2598
"	0.2321	0.05916	"	0.4740	0.1254	8.0	0.4123	0.1053
"	0.2905	0.0749	"	0.4830	0.1275	8.3	0.4203	0.1079
"	0.3214	0.0828	"	0.4933	0.1307	8.3	0.7789	0.2089

The authors also give results for the distribution of HCN at 15° between Benzene and aqueous solutions of KCl, KNO₃, CsNO₃, NaNO₃, LiNO₃, urea and glycerol. Results are given by Gross and Iser, 1930 for the distribution of HCN at 15° between Benzene and aqueous solutions of LiCl, NaCl, NaNO₃, K₂SO₄, MgCl₂, MgSO₄ and La₂(SO₄)₃. Results are given by Randall and Halford, 1930, for the distribution of HCN at 25° between Benzene and aqueous solutions of Hydrogen Silver Cyanide (HAg(CN)₂).

FREEZING-POINTS IN THE SYSTEM HYDROGEN CYANIDE - DIETHYL ETHER
(Birckenbach and Buchner, 1940)
(Selected Data)

t°	Mol. % (C ₂ H ₅) ₂ O	Solid Phase	t°	Mol. % (C ₂ H ₅) ₂ O	Solid Phase	t°	Mol. % (C ₂ H ₅) ₂ O	Solid Phase
-17.5	4.8	HCN	-63.4	44.3	HCN	-114.0	64.6	1:1
-22.5	13.1	"	-70.0	46.4	"	-117.0	69.5	"
-29.1	20.0	"	-77.9	48.7	"	-119.3	72.3	"
-34.5	25.8	"	-82.6	49.9	"	-121.5	78.3	" + E
-39.2	29.2	"	-88.0	52.7	1:1	-119.8	82.1	E
-44.5	33.9	"	-95.8	55.9	"	-118.5	87.4	"
-53.4	38.7	"	-102.6	57.8	"	-118.0	90.8	"
-56.5	40.6	"	-107.0	60.5	"	-116.8	100.0	"

E = (C₂H₅)₂O 1:1 = (C₂H₅)₂O·HCN

H HYDROGEN

The liquid-vapor equilibrium and liquid densities in the system Hydrogen Cyanide - Cyanogen Chloride at 15° are reported by Gordon and Benson (1946).

Over 3000 ml (STA) of HCN dissolve in 1 ml of dimethyl formamide at 30°, with a partial pressure of HCN = 1 atm. (Dupont, 1955)

CNO HYDROGEN CYANATE HCNO (Cyanic Acid)

FREEZING-POINTS IN THE SYSTEM HYDROGEN CYANATE - WATER^a (Linhard, 1938)

Although cyanic acid decomposes in presence of water it was found that mixtures of the two are stable at sufficiently low temperatures and the following results were obtained for the freezing-point curve.

t° (cor.)	Mols. HCNO per 100 Mols. HCNO + H ₂ O	Solid Phase	t° (cor.)	Mols. HCNO per 100 Mols. HCNO + H ₂ O	Solid Phase
-23.5	29.3	H ₂ O (Ice)	- 68.8	58.5	H ₂ O
-28.7	33.3	"	- 83.6	62.8	"
-33.7	38.3	"	-102.5 Eutec.	67.0	" + HCNO
-39.6	43.2	"	-101.0	68.1	HCNO
-42.2	45.0	"	- 97.2	74.9	"
-50.0	49.8	"	- 93.2	83.6	"
-62.0	55.3	"	- 86.8 m.pt.	100.0	"

Cl HYDROGEN CHLORIDE HCl (Hydrochloric Acid)

SOLUBILITY OF HCl IN WATER (Deicke; Roscoe and Dittmar, 1859)

t°	cc HCl per 100 cc H ₂ O	Density	Gms. HCl per 100 g. Sol.	Gms. HCl per 100 g. H ₂ O
0	525.2	1.2257	45.15	82.31
4	497.7	1.2265	45.44 ^a	79.73
8	480.3	1.2185	43.83	78.03
12	471.3	1.2148	43.28	76.30
14	462.4	1.2074	42.83	74.92
18	451.2	1.2064	42.34	73.41
20	...	...	...	71.9b
23	435.0	1.2014	41.54	71.03
25	...	...	41.2a	...
30	...	...	40.23	67.3
40	...	...	38.68	63.3
50	...	...	37.34	59.6
60	...	...	35.94	56.1

^aCupr, 1926, 1928; ^bKnight and Hinshelwood, 1927 in gms. per 100 cc sat. sol.

(Contd.)

SOLUBILITY OF HCl IN WATER--Cont.

Results at a Total Pressure = 1 atm.
(Roozeboom, 1884)

t°	Gms. HCl per 100 gms. H ₂ O	t°	Gms. HCl per 100 gms. H ₂ O
-24	101.2	-15	93.3
-21	98.3	-10	89.8
-18.3	96	-5	86.8
-18	95.7	0	84.2

Results of Roscoe and Dittmar, 1859 at 0°		Results of Bates and Kirschman, 1919 at 25°		Results of Roozeboom, 1884 at other temperatures and pressures		
Partial Pressure HCl mm.	Gms. HCl per 100 g. H ₂ O	Partial Pressure HCl mm.	Moles HCl per 1000 gms. H ₂ O	t°	Total pressure mm.	Gms. HCl per 100 gms. H ₂ O
60	61.3	0.0182	4.0	-2318	...	84.2
100	65.7	.0530	5.0	-21	334	86.8
150	68.6	.140	6.0	-19	580	92.6
200	70.7	.348	7.0	-18	900	98.4
300	73.8	.844	8.0	-17.7	1073	101.4
400	76.3	1.93	9.0			
500	78.2	4.20	10.0			
600	80.0					
750	82.4	Further data are given by Dobson and Masson, 1924.				
1000	85.6					
1300	89.5					

Cl

THE SYSTEM HCl - H₂O (FREEZING-POINTS)

(Composite curve from results of Roloff, 1895; Pickering, 1893(a);
Roozeboom, 1884, 1889 and Rupert, 1909.)

t°	Gms. HCl per 100 Gms. Sat. Sol.	Solid Phase	t°	Gms. HCl per 100 Gms. Sat. Sol.	Solid Phase
-1.706	1.66	Ice	-18.4	48.6	HCl·2H ₂ O
-14.97	10.02	"	-17.7 m.pt.	50.3	"
-28.84	14.51	"	-18.7	52.85	"
-40	17.40	"	-19.4	54.1	"
-60	21.30	"	-20.8	55.7	"
-80	24.20	"	-21.3	56.5	"
-86 Eutec.	24.8	" +HCl·3H ₂ O	-23.2	57.3	"
-50	30.1	HCl·3H ₂ O	-23.5 Eutec.	...	" +HCl·H ₂ O
-40	32.7	"	-21.5	58.2	HCl·H ₂ O
-30	36.5	"	-20.7	59.1	"
-24.9m.pt.	40.3	"	-18.4	61.1	"
-27.5	44	" +HCl·2H ₂ O	-17.4	62.4	"
-23.8	45.7	HCl·2H ₂ O	-15.4	65.4	"
-21.2	45.9	"	-15.35	66.8	"

(Contd.)

H HYDROGEN

At about -15.35 two liquid layers are formed. Data for these are as follows:

HCl layer				H ₂ O Layer			
t° of Saturation	Gms. H ₂ O per 100 Gms. Sat. Sol.	t°	Gms. HCl per 100 Gms. Sat. Sol.	d of Sat. Sol.	t°	Gms. HCl per 100 Gms. Sat. Sol.	d of Sat. Sol.
Below -50	0.008	-20	67.65	1.279	15	64.70	1.231
" -50	0.017	-15	67.29	1.269	20	64.19	1.228
Bet. -15 and 0°	0.077	-10	66.71	1.260	30	63.21	1.229
Above 45	0.021	-5	66.44	1.255	35	62.90	1.227
"	0.052	0	65.85	1.247	40	62.27	1.218
"	0.11	+5	65.48	1.245	45	61.76	1.212
"	0.13	10	65.18	1.240	50	61.65	1.219

For additional data on this system see Baume and Tykociner, 1914.

FREEZING-POINTS OF DILUTE AQUEOUS HYDROCHLORIC ACID SOLUTIONS (Chadwell, 1927)

The determinations were made with the highest possible precision. A platinum thermometer and Wheatstone bridge were used for measuring the temperatures. The analyses were made upon solutions in contact with a large amount of added ice.

F.pt. lowering below 0° C	Gm. Equiv. HCl per 1000 gms. H ₂ O	F.pt. lowering below 0° C	Gm. Equiv. HCl per 1000 gms. H ₂ O
-0.2934	0.08321	-2.3664	0.6363
-0.5033	0.1427	-2.5465	0.6785
-0.7145	0.2024	-2.6114	0.6969
-0.7771	0.2198	-2.9420	0.7736
-0.8440	0.2374	-3.1219	0.8187
-1.1000	0.3080	-3.4545	0.8945
-1.1202	0.3137	-3.8192	0.9765
-1.4738	0.4082	-4.0721	1.0324
-1.9344	0.5275		

Additional data of Klein and Svanberg, 1920

t° of F. pt.	Normality of HCl
-0.34	0.1
-0.876	0.25
-1.807	0.5

A review of the solubility and vapor pressure data in the system HCl - H₂O is given by Schmidt, 1953. The various data are presented in graphical form. A compilation of the available data upon the partial vapor pressure of aqueous solutions of hydrochloric acid is given by Zeisberg, 1925.

SOLUBILITY OF HYDROGEN CHLORIDE IN AQ. SULFURIC ACID SOLUTIONS
(Coppadoro, 1909)

Results at 17°

Results at 40°

Results at 70°

d of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		d of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		d of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	H ₂ SO ₄	HCl		H ₂ SO ₄	HCl		H ₂ SO ₄	HCl
1.211	0	42.7	1.185	3.56	35.6	1.145	1.61	32.7
1.220	1.86	39.9	1.195	5.86	34.8	1.150	3.38	31.1
1.220	4.75	39.2	1.210	8.90	32.4	1.160	4.80	30.5
1.235	8.04	36.9	1.255	16.80	27.6	1.180	7.93	28.9
1.260	12.80	33.2	1.255	18.8	25.9	1.225	18.9	22.8
1.305	20.9	28.5	1.340	28.6	18.5	1.230	20.0	22.3
1.355	30.8	22.6	1.400	44.2	11.5	1.315	36.2	13.2
1.430	44.6	15.0	1.520	61.1	3.35	1.380	48.0	6.99
1.545	59.4	6.26	1.575	66.4	1.17	1.510	62.7	1.56
1.580	65.4	3.25	1.650	73.2	0.17	1.560	67.6	0.54
1.660	73.7	0.62	1.725	79.4	0.081	1.700	80.7	0.05
1.735	77.5	0.11	1.755	81.4	0.032	1.745	83.0	0.035
1.815	89.0	0.068	1.770	83.5	0.029	1.745	83.4	0.032

C1

SOLUBILITY OF HYDROGEN CHLORIDE IN CONCENTRATED SULFURIC ACID

AT 25° AND 760 mm.

(Cupr, 1925)

Additional determinations at other temperatures and concentrations of H₂SO₄ are given by Cupr, 1925(a), 1928.

Per cent H ₂ SO ₄	Gm. HCl per 100 gms. sat. sol.	Per cent H ₂ SO ₄	Gm. HCl per 100 gms. sat. sol.	Per cent H ₂ SO ₄	Gm. HCl per 100 gms. sat. sol.
76.43	0.3588	90.69	0.0922	97.36	0.1432
81.87	0.1420	92.20	0.0996	98.65	0.1971
86.76	0.0974	94.14	0.1082	100.00	0.4015
89.31	0.0920				

FREEZING POINTS IN THE SYSTEM HYDROCHLORIC ACID - NITRIC ACID

(Kogan and Nikolaev, 1937)

[Selected Data]

t°	Wt. % HNO ₃	Solid Phase	t°	Wt. % HNO ₃	Solid Phase	t°	Wt. % HNO ₃	Solid Phase
-111.5	0.0	A	-61 m.p.	53.81	C	-82	75.28	E
-115.2	6.76	A	-64.8	55.21	C	-75.6	76.93	E
-119	9.17	A	-76	56.36	C	-62.2	80.04	E
-122	9.64	A + B -	-77	56.57	C + D	-57.2 m.p.	83.46	E
-116	12.10	B	-67	56.4	D	-65.9	85.58	E
-110	15.58	B	-58	60.80	D	-74.2	90.48	E
-99.4	-	B + C	-54.8 m.p.	63.45	D	-86.2	92.80	E + F
-97.4 m.p. (incong.)	-	B	-67	70.94	D	-75	94.23	F
-86	34.10	C	-76	72.35	D	-64.8	95.75	F
-76.8	40.30	C	-90	73.43	D + E	-55	97.56	F
						-41.3	100.0	F

Solid Phases: A = HCl M.P. -111.5°; B = 3HCl·HNO₃ (incongruent melting point -97.4°);
C = 3HCl·2HNO₃ M.P. -61°; D = HCl·HNO₃ M.P. -54.8°; E = HCl·3HNO₃ M.P. -57.2°;
F = HNO₃ M.P. -41.3°.

H HYDROGEN

FREEZING POINTS IN THE SYSTEM HYDROCHLORIC ACID - NITRIC ACID - WATER (Kogan and Nikolaev, 1937)

The authors present the data for about 100 experimental points in the complete system, and express their results in tabular and graphic form on both weight % and mole % bases. They did not determine the freezing points along the equilibrium curves involving $\text{HCl} + \text{HCl} \cdot \text{H}_2\text{O}$, $\text{HCl} + 3\text{HCl} \cdot \text{HNO}_3$, $3\text{HCl} \cdot \text{HNO}_3 + 3\text{HCl} \cdot 2\text{HNO}_3$, and the corresponding ternary invariant points, all of which lie in the region containing more than 60% HCl. The following data were selected from the tables and graphs in order to outline the system.

C1

t°	Wt. %		Solid Phase
	HNO ₃	HCl	
- 78.5	0.0	-	Ice + C1.3
- 75.5	6.46	18.13	Ice + C1.3 + N.3
- 26.45	0.0	-	C1.3 + C1.2
- 32	11.19	38.98	C1.3 + C1.2
- 48.8	22.78	23.33	C1.3 + C1.2
- 50	25.71	23.62	C1.3 + C1.2 + N.3
- 23.5	0.0	-	C1.2 + C1.1
- 41.0	26.28	34.74	C1.2 + C1.1
- 64	33.00	24.00	C1.2 + C1.1 + N.3
- 43	-	0.0	Ice + N.3
- 70	-	0.0	N.3 + N.2
- 48.2	63.32	8.56	N.3 + N.2
- 57	48.76	20.78	N.3 + N.2
- 73.8	35.66	27.68	N.3 + N.2 + C1.1
- 84.5	-	0.0	N + N.1
- 84	63.48	18.37	N + N.1 + C1.1
- 86.2	92.80	7.20	N + C1.3N
- 92	84.46	12.56	N + C1.3N + C1.1
- 90	73.43	26.57	C1.N + C1.3N
- 96	67.32	27.74	C1.N + C1.3N + C1.1
- 77	56.57	43.43	3C1.2N + C1.N
-108	48	48	3C1.2N + C1.N + C1.1
- 99.4	39	61	3C1.N + C1.1
-122	9.64	90.36	C1 + 3C1.N
- 71	72.65	18.14	N + C1.1
- 47	28.20	23.45	N.3 + C1.2

Key: C1 = HCl, C1.1 = $\text{HCl} \cdot \text{H}_2\text{O}$, C1.2 = $\text{HCl} \cdot 2\text{H}_2\text{O}$, C1.3 = $\text{HCl} \cdot 3\text{H}_2\text{O}$,
N = HNO_3 , N.1 = $\text{HNO}_3 \cdot \text{H}_2\text{O}$, N.2 = $\text{HNO}_3 \cdot 2\text{H}_2\text{O}$, N.3 = $\text{HNO}_3 \cdot 3\text{H}_2\text{O}$,
C1.N = $\text{HCl} \cdot \text{HNO}_3$, C1.3N = $\text{HCl} \cdot 3\text{HNO}_3$, 3C1.N = $3\text{HCl} \cdot \text{HNO}_3$,
3C1.2N = $3\text{HCl} \cdot 2\text{HNO}_3$.

SOLUBILITY OF HYDROGEN CHLORIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID
(Gupr, 1926, 1928)

Results at 0°

Results at 25°

Solubility			Solubility		
Gms. CH ₃ COOH per 100 gms. aq. Solvent	Gms. HCl per 100 gms. aq. Solvent	cc HCl gas per 1.0 cc sat. sol. at 760 mm	Gms. CH ₃ COOH per 100 gms. aq. Solvent	Gms. HCl per 100 gms. aq. Solvent	cc HCl gas per 1.0 cc sat. sol. at 760 mm
11.52	76.51	479.2	11.02	63.03	390.2
19.03	72.72	461.2	22.90	55.45	349.8
27.96	66.98	430.8	33.69	51.06	325.8
48.89	55.69	366.6	48.38	42.67	275.7
72.96	41.41	276.7	70.95	30.66	200.4
79.86	37.51	251.0	87.04	21.32	139.1
89.56	31.48	210.3	95.24	14.13	91.5
89.49	31.39	209.0	99.45	8.35	53.6

Cl

MISCIBILITY OF HYDROCHLORIC ACID WITH MIXTURES OF WATER AND PHENOL AT 12°
(Schreinemakers and van der Horn van der Bos, 1912)

Composition of the Reciprocally Saturated Liquid Pairs				Composition of the Solutions in Contact with Solid Phenol		
Water Rich Layer		Phenol Rich Layer				
% HCl	% Phenol	% HCl	% Phenol	% Water	% HCl	% Phenol
0	7.45	0	72	11.22	0	88.78
3.1	6.6	0.09	78	84.5	10.7	4.8
6.6	5.3	0.2	80.3	80.38	15.64	3.98
8	5.1	0.36	82.6	72.43	24.37	3.2
10.7	4.8	0.52	84.5	60.25	36.25	3.5

Additional data for this system are given by Krug and Cameron, 1900.

Results for the distribution of HCl between H₂O and Phenol are given by Wosnessenaky and Astachow, 1925.

SOLUBILITY OF HYDROCHLORIC ACID GAS IN METHYL ALCOHOL, ETHYL ALCOHOL, AND IN ETHER AT 760 MM. PRESSURE
(de Bruyn, 1892; Schunke, 1894)

Grams HCl gas per 100 Grams Solution in:

t°	CH ₃ OH	C ₂ H ₅ OH	(C ₂ H ₅) ₂ O
-10	54.6	...	37.51 (-9.2°)
-5	...	...	37.0
0	51.3	45.4	35.6
+5	...	44.2 (6.5°)	33.1
10	...	42.7 (11.5°)	30.35
15	...	...	27.62
20	47.0 (18°)	41.0	24.9
25	...	40.2 (23.5°)	22.18
30	43.0 (31.7°)	38.1 (32°)	19.47

H HYDROGEN

SOLUBILITY OF HYDROGEN CHLORIDE IN ETHYL ALCOHOL SOLUTIONS AT 25° AT LOW PRESSURES (Jones, Lapworth, and Lingford, 1913)

Mols. HCl per liter

Partial Pressure of HCl in mm.	Mols. HCl per liter		
	Absolute Alcohol	Alcohol + 0.5 mols. H ₂ O per liter	Alcohol + 1.0 mols H ₂ O per liter
0.5	0.84	1.11	1.40
1.0	1.39	1.65	1.90
2.0	2.06	2.27	2.46
3.0	2.55	2.70	2.89
4.0	2.94	3.06	3.20

Cl

EQUILIBRIUM IN SYSTEMS OF HYDROCHLORIC ACID, WATER AND ALCOHOLS (Reburn and Shearer, 1933)

The determinations were made by adding from a buret, one of the constituents to known mixtures of the other two until appearance of a permanent turbidity. The tie lines of the saturation curve thus obtained were determined by mixing suitable amounts of the three constituents to yield two liquid layers and titrating each of these for acid content.

The System HCl + H₂O + Isobutanol

—At 25°—

At 40°

At 55°

Gms. per 100 gms. sat. sol.		Tie Line Data Gms. HCl per 100 gms.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H ₂ O	C ₄ H ₁₀ O	H ₂ O layer	C ₄ H ₁₀ O layer	H ₂ O	C ₄ H ₁₀ O	H ₂ O	C ₄ H ₁₀ O
16.1	83.9	10.4	6.3	17.9	82.1	21.8	78.2
27.3	68.4	7.7	3.6	26.6	69.6	29.2	67.2
35.4	58.3	4.2	1.3	42.6	49.3	37.0	56.8
40.0	52.3			53.5	36.9	50.6	40.5
44.6	46.6			64.0	25.0	64.3	24.8
49.6	40.0			74.0	14.7	72.4	16.6
53.2	36.7			81.2	10.0	80.7	10.5
59.2	30.0			92.0	8.0	91.2	8.8
69.5	18.7						
79.8	10.3						
84.8	8.4						
91.2	8.8						

HCl + H₂O + n-Butanol at 25°

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H ₂ O	C ₄ H ₁₀ O	H ₂ O	C ₄ H ₁₀ O
21.9	78.1	66.4	23.3
29.2	67.1	75.4	13.9
39.7	54.3	84.9	8.5
51.9	39.4	91.7	8.3

HCl + H₂O + Isoamyl Alcohol
at 25°

Gms. per 100 Gms. sat. sol.

H ₂ O	C ₅ H ₁₂ O
8.9	91.1
14.15	82.7
18.90	74.6
23.10	67.7
38.8	44.1
49.5	29.8
54.3	23.6
64.9	11.3
72.0	5.16
83.6	3.60
91.4	2.79
97.1	2.90

Tie Line Data

Gms. HCl per 100 gms.

H ₂ O layer	C ₅ H ₁₂ O layer
7.83	1.99
16.13	7.30
21.7	14.7

HCl + H₂O + Cyclohexanone
at 25°

Gms. per 100 Gms. sat. sol.

H ₂ O	C ₆ H ₁₀ O
7.5	92.5
22.1	74.4
34.6	59.8
43.4	49.6
50.2	41.9
54.4	36.9
56.5	34.0
62.8	27.0
68.1	21.7
72.8	17.2
81.4	12.3
87.8	12.2

Cl

Tie Line Data

Gms. HCl per 100 gms.

H ₂ O layer	C ₆ H ₁₀ O layer
9.5	2.3
8.8	1.1

Data have been determined for the Distribution of HCl between H₂O and each of the following compounds at 25°: Amyl Alcohol, Tertiary Amyl Alcohol, *n* Butyl Alcohol and Methyl Ethyl Ketone (Archibald, 1932.)

EQUILIBRIUM IN THE SYSTEM HYDROCHLORIC ACID - DIOXANE - WATER AT 25°
(R. A. Robinson and R. C. Selkirk, 1948)

The system separates into two immiscible liquid layers. The binary systems show no immiscibility gaps.

Upper Layer

Wt. % HCl	Wt. % H ₂ O
3.52	0.85
1.17	1.29
0.87	2.63
.47	4.84
.49	7.78

Lower Layer

Wt. % HCl	Wt. % H ₂ O
10.30	8.18
11.25	14.40
10.91	18.36
9.59	22.69
5.76	21.55

Freezing Points of HCl - Dioxane Solutions
(Mezhenni, 1954)

Mole % HCl	t°	Mole % HCl	t°	Mole % HCl	t°
0.0	11.7	4.75	9.53	9.0	6.4
3.78	9.9	5.2	9.0	10.1	5.8
4.14	9.5	5.8	8.2	11.5	5.0
4.55	9.5	7.2	7.6		

(Contd.)

H HYDROGEN

At 20° a saturated solution of HCl in dioxane contains 45 mole % HCl.
 At 12° " " " " " " " " 52 mole % HCl.
 (Mezhenni, 1954)

DISTRIBUTION OF HYDROGEN CHLORIDE BETWEEN WATER AND BENZENE

Results at 20° (Knight and Hinshelwood, 1927)						Results at 25° (Wynne-Jones, 1930)	
Gms. HCl per 1000 cc		Gms. HCl per 1000 cc		Gms. HCl per 1000 cc		Gm. Mols. HCl per 1000 gms.:	
H ₂ O layer	C ₆ H ₆ layer	H ₂ O layer	C ₆ H ₆ layer	H ₂ O layer	C ₆ H ₆ layer	H ₂ O layer	C ₆ H ₆ layer
718.8	18.50	420.2	2.47	212.0	0.252	9.603	0.00213
604.0	17.7	379.8	1.818	165.9	0.100	10.215	0.00340
549.3	17.4	343.3	1.264	134.0	0.056	10.508	0.00423
509.0	15.7	312.0	0.929	94.8	0.028	11.43	0.00768
504.6	15.62	289.3	0.706	43.3	0.0036	11.99	0.0110
492.5	8.92	259.0	0.532	19.5	0.0002	12.93	0.0216
448.5	3.72	236.1	0.382	12.3	0.0001		

1000 cc benzene previously saturated with H₂O dissolve 18.31 gms. HCl at 20° and 760 mm.

1000 cc benzene simultaneously saturated with H₂O and HCl dissolve 18.50 gms. HCl at 20° and 760 mm. (Knight and Hinshelwood, 1927)

SOLUBILITY OF HYDROGEN CHLORIDE IN BENZENE

t°	Pressure HCl	Solubility						Author
20	760 mm.	16.91 gms. HCl per liter sat. sol.						(Fairbrother and Balkin, 1931)
		16.8 " " " " " "						(Knight and Hinshelwood, 1927)
25	0.026 Atm.	0.014 moles HCl per 1000 gms. sol.						(O'Brien and Kenny, 1940)
	.078	.040 " " " " " "						
	.100	.047 " " " " " "						
	.111	.048 " " " " " "						
	.197	.096 " " " " " "						
	.211	.112 " " " " " "						
	.391	.191 " " " " " "						
	.601	.273 " " " " " "						
30	1 Atm.	2.33 moles per 1000 gms. solvent						(O'Brien, 1941)
40	1 Atm.	2.91 " " " " " "						" "

DISTRIBUTION OF HYDROCHLORIC ACID BETWEEN WATER AND NITROBENZENE AT 25°
(Wynne-Jones, 1930)

Gm. Mols. HCl per 1000 gms.		Gm. Mols. HCl per 1000 gms.		Gm. Mols. HCl per 1000 gms.	
H ₂ O layer	C ₆ H ₅ NO ₂ layer	H ₂ O layer	C ₆ H ₅ NO ₂ layer	H ₂ O layer	C ₆ H ₅ NO ₂ layer
9.635	0.0027	14.84	0.0707	18.05	0.335
11.147	0.0080	15.21	0.0833	18.38	0.394
11.61	0.0109	16.46	0.164	19.33	0.556
12.84	0.0229	17.19	0.223	19.52	0.603
13.34	0.0396	17.76	0.292	20.42	0.833

Cl

SOLUBILITY OF HYDROGEN CHLORIDE IN VARIOUS ORGANIC SOLVENTS
(Data of O'Brien and King, 1949)

K = Henry's law constants from: $p = kM$ where M is the moles HCl per 1000 gms. solvent and P is measured in atmospheres.

N = Mole fraction solubility of HCl at a partial pressure of one atmosphere.

	t°	k	N		t°	k	N
Phenetole	10	1.02	0.151	Diphenyl Ether	25	3.33	0.0494
"	20	0.90	.120	" "	30	3.52	.0442
"	25	0.70	.107	m-Nitro Toluene	25	1.65	.0768*
n-Butyl Phenyl Ether	20	1.21	.110	" "	35	2.08	.0614
" " "	25	1.37	.100				

*O'Brien and Kenny, 1940

SOLUBILITY OF HYDROGEN CHLORIDE IN SEVERAL SOLVENTS AT 20° AT 760 MM.
(Bell, 1931)

The solvents were saturated by bubbling HCl through them for about 3 hours, using some 8-10 times as much gas as required for saturation. The dissolved gas was determined by displacing it with a current of CO₂ free air and absorbing the HCl in H₂O and titrating it with normal NaOH.

S = the partition coefficient of HCl between the liquid and the vapor; that is $S = C$ (the gm. equiv. HCl per liter) ÷ 0.0417, since $S/C = 22.4 \times 293/273$; X = the mole fraction solubility calculated on the assumption that the densities of the solutions obey the ideal mixture law.

Solvent	S	X	Solvent	S	X
Hexane	3.64	0.0197	Bromoform	4.78	0.0306
Octane	4.50	0.0296	Ethyl bromide	10.3	0.0348
Dodecane	3.42	0.0314	Chloroform	13.80	0.0444
Cetane	2.28	0.0270	Bromobenzene	7.13	0.0305
Cyclohexane	3.42	0.0154	Chlorobenzene	7.63	0.0315
Carbon tetrachloride	4.54	0.0181	Benzyl chloride	9.75	0.0448
Benzene	11.05	0.0425	Benzo trichloride	4.77	0.0275
Toluene	11.90	0.0507	Tetra bromethane(s)	3.93	0.0236
Tetrachlor ethylene	3.88	0.0163	Tetra chlorethane(s)	6.20	0.0265
Trichlor ethylene	5.79	0.0206	Ethyl bromide	35.15	0.1019
Penta chlor ethane	3.86	0.0214	Ethylene chloride	14.74	0.0457

H HYDROGEN

SOLUBILITY OF HCl IN SEVERAL ORGANIC SOLVENTS--Contd. Data of Fairbrother and Balkin, 1937 at 20°, 760 mm.

Solvent	Gms. HCl per 1000 cc sat. solution
Benzene (C ₆ H ₆)	16.91
Carbon tetrachloride (CCl ₄)	6.19
Cyclo Hexane (C ₆ H ₁₂) (See also p. 1119)	4.94 (17-18°)
Cyclo Hexene (<u>CH₂CH₂CH₂CH₂CH:CH</u>)	12.29 (17-18.6°)

SOLUBILITY OF HYDROGEN CHLORIDE IN SEVERAL SOLVENTS (Hamai, 1935; Howland, Miller, and Willard, 1941)

C1 A U shaped gas buret was used by Hamai for absorbing the HCl in the several solutions. From the volume change in the gas buret, the initial and final pressures and the volume of the system, the volume of HCl actually absorbed at various pressures by the liquids was calculated. The results for 20 cc volumes of solvent at the observed pressures were plotted and the value for 760 mm pressure was found by extrapolation. The final results were calculated to Mol. fraction of HCl absorbed at 760 mm.

The solutions of H.M. and W. were shaken intermittently, and the total pressure of the vapor was measured (not the volume). The solutions were found to obey Henry's law very well, and the authors indicate several possible sources of error which may have been encountered by Hamai.

Solvent	Formula	Mol. Fraction HCl absorbed at 760mm at:			
		0°	15°	20°	25°
Tetrachlor Ethane	C ₂ H ₂ Cl ₄ 1.1-2.2	-	0.03006	0.02744	0.02481
Carbon Tetrachloride	CCl ₄ H.	-	0.01826	0.01550	0.01277
	(H.M. & W.)	0.02448	-	0.01779	0.01627
Ethylene Chloride	C ₂ H ₄ Cl ₂	-	0.04377	0.03993	0.03576
Ethylene Bromide	C ₂ H ₄ Br ₂	-	0.03754	0.03441	0.03116
Trichlor Ethane	C ₂ H ₃ Cl ₃ 1.1-2	-	0.03463	0.03101	-
Pentachlor Ethane	C ₂ HCl ₅	-	0.02396	0.02250	-
Chloroform	CHCl ₃ (H.M. & W.)	0.0354	-	0.02645	0.02227

SOLUBILITY OF HCl IN SEVERAL ORGANIC SOLVENTS AT 25° (O'Brien, Kenny, and Zuercher, 1939; O'Brien and Kenny, 1940; O'Brien, 1941)

p = partial pressure of HCl

m = Moles dissolved in 1000 gms. of solvent.

Ethylene Glycol		Benzene		Nitrobenzene		m-Nitrotoluene	
p (Atm.)	m	p (Atm.)	m	p (Atm.)	m	p (mm)	m
0.0008	1.33	0.026	0.014	0.059	0.030	13.3	0.0116
.0025	2.27	.078	.040	.213	.110	44.3	.0343
.0032	2.45	.100	.047	.278	.146	56.7	.0438
.0046	2.72	.111	.048	.312	.161	116	.0918
.0074	3.02	.197	.096	.428	.225	122	.0936
(Contd.)		(Contd.)		(Contd.)		(Contd.)	

SOLUBILITY OF HCl IN SEVERAL ORGANIC SOLVENTS AT 25°--Contd.

Ethylene Glycol		Benzene		Nitrobenzene		m-Nitrotoluene	
p (Atm.)	m	p (Atm.)	m	p (Atm.)	m	p (mm)	m
.0075	3.07	.211	.112	.654	.319	132	.1037
.0086	3.11	.391	.191	.636	.323	167	.1385
.0079	3.13	.601	.273	.689	.338		
.0357	4.66			1.000	1.77		
.135	6.57	At 30°		At 20°		o-Nitrotoluene	
.139	6.63					31.9	0.0233
.172	6.92	1.000	2.33	1.000	1.59	53.1	.0382
.424	8.78	At 40°				112	.0821
Chlorobenzene				At 30°		113	.0839
at 30°		1.000	2.91			224	.164
1.000	4.65	n-Hexane		1.000	2.08	269	.202
		15.7	0.0042	At 40°		340	.259
at 40°		28.7	.0073				
		49.2	.0111	1.000	2.51		
1.000	5.71	81.5	.020				

Cl

SOLUBILITY OF HCl IN CYCLOHEXANE

(Wiegner, 1941)

(See also p. 1118)

Results at 19.84°

Results at 40°

Part. press.		Part. press.		Part. press.		Part. press.	
HCl (mm)	N _{HCl}	HCl (mm)	N _{HCl}	HCl (mm)	N _{HCl}	HCl (mm)	N _{HCl}
18.8	0.00039	473.9	0.00878	58.0	0.00094	366.3	0.00516
176.9	.00334	566.9	.01030	164.9	.00238	465.4	.00681
263.0	.00480	668.0	.01230	271.5	.00401	543.4	.00787
372.6	.00712						

The liquid-vapor compositions in the system HCl - Butane at 70°, 120°, and 180° F. are reported by Ottenweller, Holloway, and Weinrich, 1943.

At 25°, 590 ml. HCl (S.T.P.) dissolve in 1 ml. of dimethyl formamide at a partial pressure of 1 atm. (Dupont, 1955.)

DISTRIBUTION OF HCl BETWEEN ETHERS AND WATER AT ROOM TEMPERATURE
(Chalkey and Williams, 1955)

Equal volumes of solvents used M = initial molarity of aqueous HCl. E = molarity of HCl in ether layer after partition. Data are also given for the effect of methanol on the distribution in ethylether.

H HYDROGEN

DISTRIBUTION OF HCl BETWEEN ETHERS AND WATER AT ROOM TEMPERATURE--Contd.

With ethyl ether				With isopropyl ether			
M	E	M	E	M	E	M	E
1.72	0.00020	2.82	0.00053	2.16	0.00010	4.88	0.0022
1.95	.00025	3.04	.00056	2.60	.00014	5.42	.0040
2.16	.00028	4.88	.0016	2.82	.00021	6.00	.0080
2.40	.00032	5.17	.0022	3.24	.00025	8.00	.020
2.60	.00040			3.47	.00040	10.00	.10
				4.36	.00091		

FREEZING-POINTS OF MIXTURES OF ETHYL ETHER AND HYDROCHLORIC ACID

CL

Hirai, 1926

t°	Mol. (C ₂ H ₅) ₂ O per 100 mols. sat. sol.	Solid Phase	t°	Mol. (C ₂ H ₅) ₂ O per 100 mols. sat. sol.	Solid Phase
-117.7	100.0	E	-87.4	36.29	"
-118.8	89.16	"	-87.3 m.pt.	33.30	"
-119.3	86.93	"	-89.0	31.70	"
-124.2	79.68	"	-93.5	27.39	"
-127.8	77.33	"	-100.4	21.06	"
-126.5	68.04	E·2H	-104.0	18.76	"
-115.4	63.66	"	-113.5	11.20	"
-110.9	59.55	"	-115.5	10.55	"
-100.4	52.13	"	-123.6	6.08	"
-100.9	50.97	"	-123.7	5.70	H
-107.3	47.18	"	-120.8	4.65	"
-94.5	44.84	"	-120.5	3.87	"
-89.3	38.24	"	-112.5	0.00	"

E = (C₂H₅)₂O; E·2H = (C₂H₅)₂O·2HCl; H = HCl.

McIntosh, 1928

(Later determinations using a special apparatus and a very accurate thermometer.)

t°	Mol. Per cent HCl	Solid Phase
-102.9	42.5	E·H
-100	47.3	"
-98.6	50.3	"
-97.9	54.2	"
-100.4	56.5	"
-82.0	65.6	E·2H
-83.2	67.6	"
-84.8	70.6	"
-97.6	71.6	"
-99.6	80.5	E·5H
-96.2	81.5	"
-92.9	83.6	"
-94.2	85.0	"

E·H = (C₂H₅)₂O·HCl; E·2H = (C₂H₅)₂O·2HCl; E·5H = (C₂H₅)₂O·5HCl.

FREEZING-POINTS OF MIXTURES OF HYDROCHLORIC ACID AND ACETONE
(Hirai, 1926; McIntosh, 1928)

t°	Mol. Per cent HCl	Solid Phase	t°	Mol. Per cent HCl	Solid Phase
- 94.5	0.0	(CH ₃) ₂ CO	-84.6	57.7	(CH ₃) ₂ CO·HCl
-107.0	14.43	(CH ₃) ₂ CO·HCl	-82.7	55.56	"
-114.6	27.29	"	-86.6	57.26	"
- 91.5	36.5	"	-92.8	60.39	"
- 85.7	42.99	"	-81.2	69.7	2(CH ₃) ₂ CO·5HCl
- 76.9	47.1	"	-80.8	71.7	"
- 78.0	54.0	"	-85.3	74.3	"
- 80	52.91	"			

Cl

Data for the solubility of HCl in solutions of various benzene derivatives in toluene and in n-heptane are given by Brown and Brady, 1949, 1952.

Data for the reciprocal solubility of HCl (also of CO₂, SO₂ and NH₃) and the vapors of Ether, Acetone, Methyl Alcohol and Chloroform, as determined by measuring at 25° the change in pressure produced by adding weighed amounts of the volatile liquid to a given volume of HCl gas, are given by MacFarlane and Wright, 1934.

Freezing-point data are given for the following mixtures:

HCl + Chloroform	(Baume and Borowski, 1914)
" + Methyl Alcohol	(" " " " ; Baume and Pamfil, 1911, 1914; Maass and McIntosh, 1913)
" + Methyl Chloride	(Baume and Tybociner, 1914)
" + Methyl Ether	(Maass and McIntosh, 1912; Baume, 1911, 1914)
" + Propionic Acid	(Baume and Georgitses, 1912, 1914)
" + Hydrogen Sulfide	(" " " " ")
" + Magnesium Chloride	(Dernby, 1918)
" + Sodium Chloride	(" ")
" + Sulfur Chloride	(Terrey and Spong, 1932)
" + Sulfur Dioxide	(Baume and Pamfil, 1911, 1914)
" + Chlorine	(Wheat and Browne, 1940)

PERCHLORIC ACID HClO₄
(Hydrogen Perchlorate)

ClO

SOLUBILITY IN WATER
(Brickwedde, 1949)

The freezing points of various solutions of Perchloric Acid were determined from cooling curves and the results do not agree well with those of van Wyk (given in table following). The author points out several factors which make it difficult to evaluate the older work. The precision of the present measurements was excellent. Extensive tables of the densities of Perchloric Acid Solutions are also given. The following data were read by the author from a plot of the experimentally determined points.

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t°	Gms. HClO ₄ per 100 gms. Sat. Sol.		Solid Phase	t°	Gms. HClO ₄ per 100 gms. Sat. Sol.		Solid Phase
0	0		H ₂ O	-46.8	48		HClO ₄ ·xH ₂ O
-1.87	5		"	-45.0	50		"
-4.25	10		"	-45.4	52		"
-7.37	15		"	-49.1	54		"
-11.75	20		"	-56.6	56		"
-18.2	25		"	-56.8	56.1		HClO ₄ ·xH ₂ O+HClO ₄ ·yH ₂ O
-26.5	30	"	"	-51.4	58		HClO ₄ ·yH ₂ O
-39.1	35	"	"	-46.7	60		"
-56.8	40	"	"	-43.2	62		"
-59.7	40.7		H ₂ O+HClO ₄ ·xH ₂ O	-40.5	64		"
C10 -57.0	42		HClO ₄ ·xH ₂ O	(-38.4)	66		"
-53.2	44		"	-29.9	70		HClO ₄ ·zH ₂ O
-49.6	46		"				

(HClO₄ - H₂O) DATA OF VAN WYK, 1902, 1905 (See above)

Mixtures of HClO₄ and water were cooled until crystals appeared, and then very gradually warmed and constantly stirred while an observation was made of the exact temperature at which the last crystal disappeared. At certain concentrations and temperatures unstable solid phases were obtained. Also, curves for two series of mix crystals were encountered. The methods for detecting these phases consisted of seeding the saturated solutions with the several different crystalline forms, and observing the change in rate of cooling during the solidification of the mixture. The data for the mix-crystal curves I and II are not given in the following table:

t°	Mols. HClO ₄ per 100 Mols. HClO ₄ +H ₂ O		Solid Phase	t°	Mols. HClO ₄ per 100 Mols. HClO ₄ +H ₂ O		Solid Phase
0	0		Ice	-32	26		HClO ₄ ·2½H ₂ O
-10	5		"	-29.8	28.57		"
-21	7		"	-44	27		HClO ₄ ·2H ₂ O
-34.5	9		"	-41	27.25		"
-54	11		"	-34	28		"
-50.5	19		HClO ₄ ·3½H ₂ O	-24	29.9		"
-45	20		"	-17.8m.pt.	33.3		"
-42.3	21		"	-21.5	36		"
-41.4	22.22		"	-23.6	36.5		" + HClO ₄ ·H ₂ O
-43	23.5		"	-12.5	37		HClO ₄ ·H ₂ O
-40.5	22.5		HClO ₄ ·3H ₂ Oα	+3	38		"
-39.5	22.75		"	28	40.8		"
-37.6	24		"	40	43.7		"
-37.5	26		"	50 m.pt.	50		"
-38.8	27		"	45	59.9		"
-47.8	22.5		HClO ₄ ·3H ₂ Oβ	27.5	71.5		"
-44	24		"	17	77.2		"
-43.5	24.5		"	+2.2	83.3		"
-43.2	25		"	-21.5	90.7		"
-44.5	26		"	-40	94		"
-37.2	25		HClO ₄ ·3H ₂ Oα + HClO ₄ ·2½H ₂ O	-120	100		"

Sumarokova and Usanovich (1946) report the conductivities, densities and viscosities of mixtures of Perchloric Acid with Acetic Acid, Mono-, Di-, and Tri-Chlor Acetic Acid.

HYDROGEN FLUORIDE HF
(Hydrofluoric Acid)

F

FREEZING-POINTS OF MIXTURES OF HYDROGEN FLUORIDE AND WATER
(Cady and Hildebrand, 1930)

The mixtures were contained in a gold cup provided with a gold plated stirrer. The temperatures were measured with a thermocouple encased in a platinum tube. To about 100 cc of solution in the gold cup enough liquid air was added to partially freeze the solution. After stirring for 15 minutes the temperature was read and immediately afterwards a sample was removed for analysis. This was weighed in a paraffin lined bottle, diluted with water and titrated with NaOH using phenolphthalein as indicator. In some cases it was necessary to determine warming curves and take the final sudden change in slope as the freezing-point. The authors give the observed freezing-points as °K but in the following table they have been converted to the ordinary scale by deducting each one from -273°.

t°	Gm. Mols. per 100 Gm. Mols. HF + H ₂ O	Solid Phase	t°	Gm. Mols. per 100 Gm. Mols. HF + H ₂ O	Solid Phase
- 0.9	0.777	Ice	-75.4	69.8	2HF·H ₂ O
- 6.3	5.64	"	-75.7	71.0	"
- 9.8	8.09	"	-81.7	74.3	"
-23.0	15.65	"	-91.1	76.2	"
-41.4	21.6	"	-101.3	77.6	" + 4HF·H ₂ O
-60.0	26.5	"	-100.7	78.6	4HF·H ₂ O
-70.1	27.6	" + HF·H ₂ O	-100.3	79.6	"
-62.7	30.7	HF·H ₂ O	-100.2	80.0	"
-59.4	32.1	"	-100.6	81.7	"
-48.9	37.1	"	-105.4	86.4	"
-43.5	40.3	"	-110.8	88.3	" + HF
-36.1	47.8	"	-106.9	89.4	HF
-35.3	50.0	"	- 99.7	91.3	"
-35.8	51.5	"	- 93.9	93.9	"
-41.5	57.5	"	- 88.9	96.1	"
-51.0	62.7	"	- 86.9	97.4	"
-68.3	67.5	"	- 85.4	98.2	"
-75.1	68.5	" + 2HF·H ₂ O	- 82.9	100.0	"

The liquid-vapor equilibrium in the systems HF-H₂O and HF-H₂SiF₆-H₂O at atmospheric pressure were determined by Munter, Aelpi, and Kossatz, 1947. The azeotropic solution in the system HF-H₂O boils at 112.0° (750.2 mm) and contains 38.26% HF. An all-silver apparatus was used.

SOLUBILITY OF HYDROGEN FLUORIDE IN BENZENE
(Simons, 1931)

Vessels made entirely of copper were used. The vapor of HF at its b.pt. or that carried over by nitrogen from liquid HF maintained at other temperatures, was conducted into benzene until the saturation point was

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reached at selected temperatures. These results were plotted and the following values obtained from the curves.

t° of the liquid HF from which its vapor was conducted	Gm. Mols. HF dissolved per 100 gm. mols. HF + C ₆ H ₆ at:				
	20°	30°	40°	50°	60°
-77	2.48	2.03	1.58	1.12	0.71
-18	3.85	3.15	2.44	1.73	1.02
0	4.32	3.55	2.75	1.96	1.17
b.pt.	6.73	5.48	4.22	2.98	1.80

Vapor pressure results are also given.

F

SOLUBILITY OF HF IN OCTANE

Similar determinations to the above of the solubility of HF vapor at its b.pt. in octane, gave the following results. (Simons, 1931)

t° of sat. sol. in Octane	25.1°	36.0°	45.2°	51.0°	66.3°
Mols. HF per 100 mols. HF + C ₈ H ₁₈	0.338	0.276	0.235	0.194	0.170

Mutual solubilities between HF and Isobutane, n-butane, and propane from 0° - 50° were determined by Butler, Miles, and Kuhn, 1946 with varying amounts of water added.

THE SYSTEM HF-UF₆ (Rutledge, Jarry and Davis, Jr., 1953)

[Selected Data]

Formula % UF ₆	Freezing Point	Formula % UF ₆	Freezing Point	Data for the boundary of the liquid miscibility gap.	
0.00	-83.6	7.95	58	Formula % UF ₆	t° of Coalescence
-	-85.1 Eutec.	10.0	61		
0.16	- 5.0	[Miscibility gap]			
0.45	0.0	80.0	61.2	10.38	69
0.781	5.0	87.73	61.56	12.20	78
1.593	26.5	91.09	62.3	23.39	90.3
3.04	44.3	96.47	62.53	29.13	93.2
3.93	50	98.45	63.09	39.38	98.8 +
5.39	55	99.63	63.76	49.97	100.5
		100.00	64.02	55.40	95.7
				62.03	93.5
				72.96	76

Freezing-point data for mixtures of HF + KF are given by Cady, 1924, and the mixtures of HF + NH₃ by Ruff and Staub, 1933.

The freezing point diagram for the system HF-SO₂ is given by Seel and Riehl, 1955. A 1:1 compound (m.p. -84°) is formed, which yields a eutectic with added HF, and limited solid solutions with SO₂.

Melting points of mixtures of HF + IF₃ are reported by Rogers, Speirs, Parrish and Thompson, 1956.

HYDROGEN IODIDE HI
(Hydriodic Acid)

SOLUBILITY OF HYDROGEN IODIDE IN WATER AT 25°
(Bates and Kirschman, 1919)

Partial Pressure HI in mm	Moles HI Dissolved per 1000 gms. H ₂ O
0.00057	6.0
.00182	7.0
.0065	8.0
.0295	9.0
.132	10.0

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD
(Pickering, 1893a)

t°	Gm. HI per 100 Gms. Sat. Sol.	Solid Phase	t°	Gm. HI per 100 Gms. Sat. Sol.	Solid Phase
-10	20.3	Ice	-60	52.6	HI·4H ₂ O
-20	29.3	"	-40	59	"
-30	35.1	"	about -35.5 m.pt.	64	"
-40	39	"	-40	65.5	"
-50	42	"	-49	66.3	" + HI·3H ₂ O
-60	44.4	"	-48 m.pt.	70.3	HI·3H ₂ O
-70	46.2	"	-56	73.5	" + HI·2H ₂ O
-80	57.9	" + HI·4H ₂ O	-52	74	HI·2H ₂ O

Results of Klein and Svanberg, 1920

t° of F. pt.	Normality of HI
-0.35	0.1
-0.91	0.25
-1.90	0.50

EQUILIBRIUM IN SYSTEMS OF HYDROGEN IODIDE, WATER AND ALCOHOLS
(Reburn and Shearer, 1933)

The determinations were made by adding from a buret one of the constituents to known mixtures of the other two, until appearance of a permanent turbidity. The tie lines of the saturation curves thus obtained were determined by mixing suitable amounts of the three constituents to yield two liquid layers and titrating each of these for acid content.

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Results for HI + H₂O + Iso Amyl Alcohol
((CH₃)₂CHCH₂CH₂OH)

Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
H ₂ O	C ₅ H ₁₂ O	H ₂ O	C ₅ H ₁₂ O
8.50	91.5	43.2	15.7
12.0	82.8	62.3	2.76
21.0	58.8	76.6	2.55
24.0	52.6	77.5	3.03
25.8	47.5	91.2	2.98
27.8	43.2	97.2	2.80
29.1	40.1		

Results for HI + H₂O + Iso
Butyl Alcohol ((CH₃)₂CHCH₂OH)

Gms. per 100 gms. sat. sol.	
H ₂ O	C ₄ H ₁₀ O
16.1	88.9
24.9	67.0
32.0	54.7
37.8	46.7
39.6	44.3
61.9	19.3
91.2	8.81

Tie Line Data

Gms. HI per 100 gms.:	
H ₂ O layer	C ₅ H ₁₂ O layer
16.84	9.45
30.0	21.1
41.1	30.5

Tie Line Data

Gms. HI per 100 gms.:	
H ₂ O layer	C ₄ H ₁₀ O layer
11.6	8.3
4.8	4.0

F.pt. data for HI + H₂S (Bagster, 1911), HI + (CH₃)₂O. (Maass and McIntosh, 1912)

10 IODIC ACID HIO₃ (Hydrogen Iodate)

SOLUBILITY OF IODIC ACID IN WATER
(Groschuff, 1906)

t°	Gms. I ₂ O ₃ per 100 Gms. Sat. Sol.	Solid Phase	t°	Gms. I ₂ O ₃ per 100 Gms. Sat. Sol.	Solid Phase
- 0.3	1.69	Ice	16	71.7	HIO ₃
- 1.01	6.81	"	40	73.7	"
- 2.38	26.22	"	60	75.9	"
- 4.72	51.42	"	80	78.3	"
- 6.32	57.61	"	85	78.7	"
-12.25	67.40	"	101	80.8	"
-14	69.10	" + HIO ₃	110	82.1	HIO ₃ + HI ₃ O ₈
-15	70	(unstable) Ice	125	82.7	HI ₃ O ₈
-19	72	"	140	83.8	"
0	70.3	HIO ₃	160	85.9	"

SOLUBILITY OF IODIC ACID IN NITRIC ACID SOLUTIONS

Results at 25°
(Moles and Perez-Viteria,
1931, 1932)

Results at various temperatures
(Groschuff, 1906)

Wt. Per cent HNO ₃	d of the HNO ₃ + H ₂ O mixture	Gms. HIO ₃ per 100 gms. sat. sol.	t°	Gms. HIO ₃ per 100 Gms.		
				Aq. Solution	27.73% HNO ₃ Solution	40.88% HNO ₃ Solution
20.23	1.123	35.09	0	74.1	18	9
28.00	1.173	21.84	20	75.8	21	10
35.28	1.223	15.20	40	77.7	27	14
43.32	1.273	10.08	60	80	38	18
50.71	1.324	5.74				
58.66	1.366	3.25				
65.90	1.400	1.40				

PERIODIC ACID HIO₄·2H₂O
(Hydrogen Periodate)

SOLUBILITY OF PERIODIC ACID IN WATER
(Gyani and Gyani, 1949)

The temperature control was not exact and the two solid phases were not identified.

t°	Gms. HIO ₄ ·2H ₂ O per 100 gms. Sat. Sol.	Solid Phase	t°	Gms. HIO ₄ ·2H ₂ O per 100 gms. Sat. Sol.	Solid Phase
0	77.91 ^a	"A"	35	79.50 ^b	"B"
20	78.57	"A"	37	76.66	"B"
25	78.74	"A"	40	80.30	"B"
29.5	-	"A" + "B"	45	80.78	"B"
33	79.32	"B"			

^a = 62.51 gms. I₂O₇/100 gms. sat. sol. ^b = 63.81 gms. I₂O₇/100 gms. sat. sol.

SOLUBILITY OF PERIODIC ACID IN CONCENTRATED NITRIC ACID (Sp. Gr. = 1.42)
(Willard, 1939)

t°	Gms. H ₅ IO ₆ per 100 cc	Gms. H ₅ IO ₆ per 100 gms. Sat. Sol.
-12 ± 1°	5.68	3.95
+26 ± .05°	7.82	5.41

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NO NITRIC ACID HNO_3

RECIPROCAL SOLUBILITY OF NITRIC ACID AND WATER, DETERMINED BY THE FREEZING-POINT METHOD

(Kuster and Kremann, 1904; see also Pickering, 1893)

t°	Gms. HNO_3 per 100 Gms. Sat. Sol.	Solid Phase	t°	Gms. HNO_3 per 100 Gms. Sat. Sol.	Solid Phase
-10	13.9	Ice	-40	69.7	$\text{HNO}_3 \cdot 3\text{H}_2\text{O}$
-20	22.9	"	-42 Eutec.	70.5	" + $\text{HNO}_3 \cdot \text{H}_2\text{O}$
-30	27.8	"	-40	72.5	$\text{HNO}_3 \cdot \text{H}_2\text{O}$
-40	31.5	"	-38 m. pt.	77.75	"
-43 Eutec.	32.7	" + $\text{HNO}_3 \cdot 3\text{H}_2\text{O}$	-40	82.4	"
-40	34.1	$\text{HNO}_3 \cdot 3\text{H}_2\text{O}$	-50	86.5	"
-30	40.0	"	-60	88.8	"
-20	49.2	"	-66.3 Eutec.	89.95	" + HNO_3
-18.5 m. pt.	53.8	"	-60	91.9	HNO_3
-20	58.5	"	-50	94.8	"
-30	65.4	"	-41.7 m. pt.*	100	"

*Gillespie, Hughes, and Ingold, 1950.

FREEZING-POINTS OF AQUEOUS NITRIC ACID SOLUTIONS (Klein and Svanberg, 1920)

t° of f. pt.	Normality of aq. HNO_3	t° of f. pt.	Normality of aq. HNO_3	t° of f. pt.	Normality of aq. HNO_3
-0.356	0.10	-0.885	0.25	-1.797	0.50

The partial pressures of water and Nitric Acid over mixtures containing 5-100% HNO_3 at 0° and 20° were determined by Wilson and Miles (1940).

PARTITION OF NITRIC ACID BETWEEN WATER AND ETHYL ETHER AT 25° (Kooi, 1955)

The results of Bock and Bock (1950) at 19° are in excellent agreement with these. Additional data are given by Archibald (1932), Jüttner (1907), Bogdan (1905, 1906), Hantzsch (1899) and Tauret (1897).

μ = Total amount of acid in ether layer/total amount of acid in H_2O layer.

α = Molarity of acid in ether layer/molarity of acid in H_2O layer.

PARTITION OF NITRIC ACID BETWEEN WATER AND ETHYL ETHER AT 25°--Contd.

Normality original water layer	Vol. H ₂ O Vol. Ether (after shaking)			Normality original water layer	Vol. H ₂ O Vol. Ether (after shaking)		
-	1.22	-	-	5.56	1.06	0.567	0.595
0.77	1.26	0.057	0.072	5.68	1.03	0.600	0.618
1.83	1.28	0.142	0.182	6.68	0.92	0.761	0.685
2.32	1.26	0.184	0.234	7.64	0.78	0.901	0.703
2.95	1.27	0.245	0.309	8.13	0.74	0.957	0.699
3.37	1.27	0.291	0.364	8.71	0.67	1.035	0.704
3.72	1.21	0.336	0.410	9.58	0.63	1.120	0.707
4.64	1.18	0.447	0.518	10.30	0.59	1.185	0.710

NO

PARTITION OF NITRIC ACID BETWEEN WATER AND ORGANIC SOLVENTS AT 25°
(Kooi, 1955) μ = Total amount of acid in ether layer/total amount of acid in H₂O layer α = Molarity of acid in organic layer/molarity of acid in H₂O layer.

dibutyl carbitol + H ₂ O				methylisobutyl ketone + H ₂ O			
Normality original water layer	Vol. H ₂ O Vol. organic (after shaking)	μ	α	Normality original water layer	Vol. H ₂ O Vol. organic (after shaking)	μ	α
-	0.99	-	-	-	1.01	-	-
0.77	1.00	0.101	0.101	0.77	1.07	0.093	0.099
1.83	0.99	0.227	0.226	1.86	1.00	0.202	0.202
2.96	0.94	0.372	0.350	3.15	0.97	0.331	0.316
3.15	0.93	0.400	0.372	4.37	0.90	0.445	0.401
3.37	0.92	0.431	0.393	5.54	0.86	0.537	0.451
4.64	0.81	0.592	0.480	6.53	0.77	0.612	0.484
5.68	0.77	0.692	0.533	7.56	0.74	0.672	0.532
6.68	0.75	0.741	0.539	8.71	0.69	0.748	0.524
7.64	0.68	0.784	0.542	10.30	0.63	0.867	0.538
8.71	0.65	0.850	0.544				
9.58	0.60	0.907	0.545				
10.30	0.57	0.915	0.523				

Data for the partition of HNO₃ between H₂O and n-butanol, n-amyl alcohol, and methyl ethyl ketone are given by Archibald, 1932.

For the partition between nitrobenzene and water, see Euler and Svanberg, 1917.

N HYDROGEN

DISTRIBUTION OF HNO_3 BETWEEN WATER AND NITROMETHANE AT 20° (Warner, 1953)

Gms. HNO_3 per gm. of		Gms. HNO_3 per gm. of	
Aqueous phase	CH_3NO_2 phase	Aqueous phase	CH_3NO_2 phase
0.195	0.195*	0.277	0.075
.260	.177	.258	.050
.286	.160	.197	.016
.292	.136	.140	.005
.286	.103		

NO *System completely miscible.

MELTING POINT DATA IN THE SYSTEM HNO_3 - N_2O_4

The various results have been summarized by Elverum, Jr. and Mason (1955) in a phase diagram. Above -12.5° (to $+60^\circ$) a two-liquid region exists.

Pascal and Garnier, 1919

t°	Gms. HNO_3 per 100 gms. mixture	Solid Phase
-42	100.0	HNO_3
-58.5	90.6	"
-70	85	"
-73 (Eutec.)	82	" + N_2O_4 (solid)
-58.5	70	N_2O_4 (solid)
-48.5	66	"
-32	62	"
-21.4	60	"

Elverum, Jr., and Mason, 1955
(Selected Data)

Mole % N_2O_4	M. P. °	Mole % N_2O_4	M. P. °
Solid phase HNO_3		Solid phase N_2O_4 (+ liquid A)	
0.0	-41.7	35.48	-37.6
6.31	-45.2	38.89	-26.9
10.91	-49.9	42.10	-16.4
14.78	-55.6		
17.20	-60.2	Solid phase N_2O_4 (+liquid B)	
18.73	-64.5		
Solid phase $\text{N}_2\text{O}_4 \cdot 2\text{HNO}_3$		96.56	-12.5
		98.45	-12.0
21.10	-55.4	100.0	-11.2
27.46	-47.1		
32.24	-39.0		

(Contd.)

Two-liquid Region Data
(Klemenc and Spiess, 1947)

The authors determined the composition of the coexisting liquid phases up to the consolute point using anhydrous HNO_3 , and then in $\text{HNO}_3 + \text{H}_2\text{O}$ where the HNO_3 was 21 N. Data in excellent agreement with these are reported by Corcoran, Reamer and Sage, 1954. See also Pascal and Garnier, 1919 and Bousfield, 1919.

	Anhydrous HNO_3		21N HNO_3		
	Wt. % HNO_3		Wt. 2 HNO_3		
t°	No-rich phase	HNO_3 -rich phase	No-rich phase	HNO_3 -rich phase	NO
-20	2.3	47.4	0.7	56	
-15	2.7	47.2	1.7	55.5	
-10	3.3	47.0	2.6	55.0	
- 5	3.9	46.9	3.5	54.5	
0	4.0	46.7	4.4	54.0	
5	5.5	46.6	5.4	53.5	
10	6.3	46.4	6.5	52.9	
15	7.3	46.3	7.7	52.2	
20	8.2	46.2	9.2	52.3	
25	9.2	46.0	11.0	50.2	
30	10.2	45.9	13.2	48.6	
35	11.3	45.6	16.4	46.3	
40	12.5	45.2	21.8	42.0	
42.6	-	-	31.7	31.7	
45	13.9	44.6	(upper consolute point)		
50	15.9	43.4			
55	18.9	41.2			
60	25.8	36.6			
61	31.4	31.4			
	(Upper consolute point)				

(Upper consolute point)

Data for the equilibrium between NO , NO_2 and solutions of HNO_3 at 0° are given by Epstein, 1939.

Solid-liquid equilibrium data for part of the systems $\text{HNO}_3 + \text{N}_2\text{O}_4 + \text{H}_2\text{O}$, $\text{KNO}_3 + \text{HNO}_3$ and $\text{NH}_4\text{NO}_3 + \text{HNO}_3$ are given by Elverum, Jr. and Mason, 1955.

Freezing point curves for solutions of H_2O , N_2O_3 , KNO_3 , NH_4NO_3 , HClO_4 , H_2SO_4 and acetyl nitrate in 100% HNO_3 are given by Dunning and Nutt, 1951.

THE SYSTEM $\text{HNO}_3 - \text{H}_2\text{SO}_4 - \text{H}_2\text{O}$

The melting points of various portions of the system $\text{HNO}_3 + \text{SO}_3$ and $\text{HNO}_3 + \text{SO}_3 + \text{H}_2\text{O}$ have been investigated to determine the nature of various nitrating acids. The presence of the compounds $\text{HNO}_3 \cdot 2\text{SO}_3$, $2\text{HNO}_3 \cdot 3\text{SO}_3$, $\text{HNO}_3 \cdot 3\text{SO}_3$ and possibly $4\text{HNO}_3 \cdot 5\text{SO}_3$ have been reported by Heertjes and Revallier (1950, 1954). A liquid miscibility gap is also present.

(Contd.)

H HYDROGEN

Other data are given by Atelin and Borodastova (1949) [m.p.'s in system $\text{H}_2\text{SO}_4 + \text{HNO}_3 \cdot 2\text{SO}_3$], Holmes, Hutchinson, and Zieber, 1931 [system $\text{H}_2\text{SO}_4 + \text{HNO}_3 + \text{SO}_3$].

Vapor pressures in the system $\text{H}_2\text{SO}_4 + \text{HNO}_3 + \text{SO}_3$ at 30°, 40°, and 50° are given by Gelfman, 1946. The heats of mixing at 30° are reported by Gelfman, 1947.

Freezing-points of mixtures of $\text{HNO}_3 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$ over a wide range of composition, especially for the region of high concentration of H_2SO_4 , have been determined by Holmes, 1920, Carpenter and Lehrman, 1925 and Holmes, Hutchinson and Zieber, 1931. These latter investigators give a triangular diagram constructed from all available data on this system, showing the iso thermal freezing curves for mixtures of varying percentage composition.

HO

The system $\text{HNO}_3 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$ has also been studied as follows:

1. Boiling points and liquid-vapor equilibria (Berl, 1922)(Babkin, 1937).
2. Heats of mixing (McDavid, 1922)(Chedin, Feneant, and Watelle, 1947).
3. Specific heats of mixtures (Pascal and Garnier, 1920).
4. An Enthalpy vs. temperature nomograph is given by McCurdy and McKinley, 1942.

THE SYSTEM $\text{HNO}_3 - \text{CH}_3\text{COOH}$
(Taylor and Follows, 1951)

Data given by Miskidzh'yan and Trifonov, 1947 is in excellent agreement.

Mole % HNO_3	M.P. °	Mole % HNO_3	M.P. °	Mole % HNO_3	M.P. °
0.00	+16.6	40.42	-30.0	70.45	-45.9
19.55	- 6.8	49.43	-24.7	86.74	-49.9
27.12	-24.9	49.84	-23.9	100.0	-41.6
32.57	-41.1	61.72	-30.6		

O WATER H_2O

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS

Note - Data for the Reciprocal Solubility of Water in Organic Solvents, in addition to those here shown, will be found in Volume III under the respective Organic Compounds.

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd.

Solvent	t°	Solubility Mole Fraction H ₂ O	Author
Triethylene tetramine	4.5° *	0.588	(Copley, Ginsberg, Zellhoefer, and Marvel, 1941)
Tetraethylene pentamine		.622	
Trimethyl triethylene tetramine		.398	
Pentamethyl triethylene tetramine		.523	
Triacetyl trimethyl triethylene tetramine		.610	
Hexamethylene diamine		.382	
N, N-dimethyl acetamide		.232	
Ethylene glycol		.207	
Glycerol		.239	
Carbitol		.126	
Dimethyl ether of tetraethylene glycol		.099	
Triethyl phosphate		.104	

*The solubilities were determined at 32.2° using a partial pressure of water equal to the vapor pressure at 4.5°.

Solvent	t°	Gms. H ₂ O per 100 gms. Solvent	Author
Methyl Methacrylate	room temp.	1.0	(Shanley and Greenspan, 1947)
Allyl CR-39 Monomer		3.0	
Dimethyl phthalate		1.6	
Diethyl phthalate		1.0	
Ethyl acetate		3.5	
Aniline		3.5	

Di-n-propyl amine (Data of Hobson, Hartman, and Kanning, 1941)

t°	Gms. Amine per 100 gms. Sat. Sol.	t°	Gms. Amine per 100 gms. Sat. Sol.	t°	Gms. Amine per 100 gms. Sat. Sol.
52.6	1.96	-4.5	25.21	17.5	73.33
44.1	2.42	-4.8	33.69	24.7	78.69
36.1	2.91	-2.9	44.68	31.2	82.15
12.2	5.86	-1.5	47.54	39.0	85.83
-0.6	9.33	4.2	60.40	49.0	89.26
-2.2	12.27	8.0	64.06	74.8	93.25
-3.5	15.28				

Gms. H₂O per 100 gms. Sat. Sol.

	0°	25°	30°	Author
CH ₂ Cl ₂	0.0849	0.167	0.196	(Staverman, 1941)
CH ₃ CHCl ₂	.0460	.0966	.115	
CH ₂ ClCH ₂ Cl	.0900	.187	.22	
CH ₂ BrCH ₂ Br	-	.0657	.0715	
CH ₃ CCl ₃	.0162	.0339	.042	
CH ₂ ClCHCl ₂	.062	.119	.159	
CHCl ₂ CHCl ₂	.0584	.110	.132	
CH ₂ ClCCl ₃	.0230	.0555	.060	
CHCl ₂ CCl ₃	.0162	.0347	.0414	

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd.

Carbon tetrachloride (Staverman, 1941; Clifford, 1921; Rosenbaum and Walton, 1930)

t°	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. sat. sol.
0	0.0050(S)	28.5	0.013 (C)
10	0.00711 (R.& W.)	30	0.0158 (S.)
20	0.00844 (R.& W.)		0.0109 (R.& W.)
24	0.010 (C.)	40	0.0152 (R.& W.)
25	0.0116 (S.)	50	0.0237 (R.& W.)

0 The presence of Cs₂ in CCl₄ as an impurity was found to increase the solubility of water in this solvent about 50 percent. (R.&W.)

Chloroform t°	0°	24.5°	25°	26.7°	27.8°	30°
Gms. H ₂ O per 100 gms. sat. sol.....	0.0530	0.084	0.0932	0.107	0.116	0.113
Author.....	(S.)	(C.)	(S.)	(C.)	(C.)	(S.)
S. = Staverman, 1941			C. = Clifford, 1921			

Benzene The results of Hill, 1923 (by the increase in solubility of AgClO₄ in the presence of small amounts of water, see p. 80), Groschuff, 1911 (synthetic cloud-point method), Clifford, 1921 (H₂O analysis), Tarassenkow and Poloshinzewa, 1931, 1932 (synthetic method), Rosenbaum and Walton, 1930 (H₂O analysis), Joris and Taylor, 1948, Black, Joris and Taylor, 1948 (tritium tracer), Staveley, Jeffes, and Moy, 1943 (cloud point) and Staveley, Johns and Moore, 1951 were plotted and the values read from the average curve. The data of Hill, Groschuff, Tarassenkow and Poloshinzewa, 1931, 1932, and Staveley and coworkers are in good agreement ($\pm .005$) over the entire temperature range. At higher temperatures, the data of Rosenbaum and Walton are apparently too low ($\sim .05$). The values of Black, Joris and Taylor are consistently lower ($\sim .015$) than the average curve.

t°	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. sat. sol.
5	0.033	35	0.095	60	0.208
10	.040	40	.112	65	.242
15	.047	45	.134	70	.275
20	.055	50	.156	75	.311
25	.067	55	.181	77	.328
30	.080				

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd.

Toluene		(Taraassenkow and Polosahinzewa, 1931, 1932)		(Rosenbaum and Walton, 1930)	
t°	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. C ₆ H ₅ CH ₃
-9.0	0.002	48.0	0.097	10	0.0335
-3.5	0.005	60.5	0.153	20	0.0450
+10.5	0.020	76.0	0.254	30	0.0600
18.0	0.034	93.0	0.413	40	0.0733
30.0	0.053			50	0.0953

Carbon disulfide	25°	0.010 gms. H ₂ O/100 gms. sat. sol.	} Clifford, 1921
	26°	(.014)* "	
	27°	.012 "	

*Rotariu, Fraga and Hildebrand, 1952.

Cyclopropane Results for the Solubility of H₂O, Blood and Oils in cyclopropane (CH₂·CH₂·CH₂) are given by Orcutt and SeEVERS, 1937.

Cyclohexane	Gms. H ₂ O per 100 gms. sat. sol.	t°	Gms. H ₂ O per 100 gms. sat. sol.	t°
14	0.005	32.5	.020	
19	.010	38	.031	
20	.010*	50	.015	
	.0087†	53	.015†	
28.5	.015			

*Black, Joris and Taylor, 1948

† = Berkengeim, 1941

n-Pentane (Data of Joris and Taylor, 1948; Black, Joris, and Taylor, 1948)

iso-Pentane Tritium Oxide was used as a tracer and the amount of
1,5-Hexadiene dissolved water was determined by using a Geiger-Muller
1-Heptene counter. In addition to the results below, the authors
n-Heptane report the solubility of water in 1, 3-Butadiene, 1-Butene,
n-Heptane 2-Butene, Isobutylene, n-Butane, and Isobutane at 3-6 atm.
n-Octane total pressure and 5°-22°. The data below are given at 1
n-Butane atm. total pressure.

	Gms. H ₂ O per 100 gms. Solvent	Gms. H ₂ O per 100 gms. Solvent	Gms. H ₂ O per 100 gms. Solvent
	t°	t°	t°
1-Butene			
2-Butene			
1,3-Butadiene			
iso-Butylene			
iso-Butane			
	<u>n-Pentane</u>	<u>iso-pentane</u>	<u>1-Heptene</u>
	5.5 0.0036	6.0 0.00439	10.0 0.0692
	15.0 .0061	15.3 .0066	20.1 .1126
	24.8 .0120	20.0 .0094	20.5 .1047
	<u>1,5-Hexadiene</u>	20.5 .01001	21.2 .1158
	13.5 0.0618	21.3 .0096	<u>n-Heptane</u>
	20.2 .0969	21.8 .0097	10 0.0077
		<u>n-Octane</u>	20 .0131
		20 0.0142	25 .0151

N HYDROGEN

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd. (Data of Berkengeim, 1941)

	Grams H ₂ O per 100 gms. saturated solution					
	Below 0°	0°	10°	20°	40°	
Aviation Benzene (d ₄₀ ²⁰ 0.8596)	0.0075 (-13°)	-	0.16	0.023	0.029	0.038
Cracking Benzene (d ₄₀ ²⁰ 0.8576)	0.0080 (-10°)	0.013 (-1.5°)	-	0.020	0.027	0.035
Alkylbenzene (d ₄₀ ²⁰ 0.8675)	0.0065 (-10°)	-	0.011	0.014	0.018	0.023
Iso octane (d ₄₀ ²⁰ 0.6947)	-	0.0011 (-1.5°)	-	0.0037	0.0055	0.0080
Butyl Alcohol (b.p. 116.5°-117°)	2.80 (-18°)	12.5 (-7°)	-	-	23.1	26.4
Methyl Ethyl Ketone (d ₄₀ ²⁰ 0.8112)	upper layer	-	22.5	18.5	17.2	17.2
	lower layer	-	55.5	63.3 (14°)	-	74.4
Methyl Propyl Ketone (d ₄₀ ²⁰ 0.8107)	-	-	2.11	-	3.39	3.62
Isopropyl Ether (d ₄₀ ²⁰ 0.7398)	0.64 (-20°)	0.70 (-13°)	0.75	0.80	0.87	0.91

Ethyl benzene

(Data of Filipov and Furman, 1952)

t°	Wt. % H ₂ O in Sat. Sol.		t°	Wt. % H ₂ O in Sat. Sol.		t°	Wt. % H ₂ O in Sat. Sol.	
18.2	0.0296		27.2	0.0494		36.6	0.0835	
18.3	.0308		29.2	.0595		38.8	.0917	
19.7	.0327		31.6	.0648		41.5	.1005	
22.3	.0352		32.1	.0679		43.1	.1070	
23.4	.0360		34.2	.0745		47.2	.1225	
24.2	.0388		35.1	.0777		49.5	.1300	
Chlorobenzene								
17.7	0.0275		30.4	0.0512		39.8	0.0731	
22.9	.0333		32.4	.0560		42.7	.0825	
25.2	.0382		35.3	.0621		47.9	.0955	
28.0	.0470		36.6	.0660		49.0	.0990	

Styrene

(Data of Lane, 1946)

t°	% H ₂ O in Styrene	t°	% H ₂ O in Styrene	t°	% H ₂ O in Styrene
6	0.032	27	0.060	40	0.100
14	.040	31	.084	45	.120
25	.066	34	.080	51	.123

Kerosene

Naphtha

Lube Oil

(Data of Griswald and Kasch, 1942)

Weighed amounts of water and hydrocarbons were sealed together in pyrex tubes and the cloud point of each determined. The maximum variation was $\pm 2^\circ$.

Kerosene		Naphtha		S.A.E. 20 Lubricating Oil	
t°	Gms. H ₂ O per 100 gms. Kerosene	t°	Gms. H ₂ O per 100 gms. Naphtha	t°	Gms. H ₂ O per 100 gms. Oil
112	0.1306	159	0.6404	208	0.8070
135	.2313	186	1.2051	215	.8699
169	.5456	203	1.6570	215	.9286
177	.6508	222	2.3649	250	1.6829
185	.8308			259	1.8115
191	.9029			267	2.0819
203	1.3309			272	2.3011
207	1.4377	124	0.1072	269	2.4863
216	1.8281	137	.1365	273	2.5174
228	2.4502	151	.2359	274	2.8142
251	3.1148	189	.4369	281	3.1869
264	4.4436	226	.8022		

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd.

Petroleum

(Data of Groschuff, 1911)

Paraffin oil

The synthetic, sealed tube method was used and the experiments were made with very great care. The mixtures were first superheated sufficiently to bring all the water into solution and then cooled until a fine mist was formed. The temperature of appearance and disappearance of this fine mist was determined repeatedly. The benzene was of $d_{20} = 0.8799$. The petroleum was American water white, of $d_{20} = 0.792$. It was freed from H_2O by distilling 3 times from melted Na and boiled at $190-250^\circ$ at atmospheric pressure. The paraffin oil was first heated to $120-130^\circ$ and then distilled twice under vacuum over melted Na and once without Na. Its $d_{18} = 0.883$ and b.-pt. was $200^\circ-300^\circ$ at 10 mm. pressure. Results for:

Results for:

H ₂ O in Petroleum				H ₂ O in Paraffin Oil	
Gms. H ₂ O per 100		Gms. H ₂ O per 100		Gms. H ₂ O per 100	
t°	Gms. Sol.	t°	Gms. Sol.	t°	Gms. Sol.
- 2	0.0012	59	0.031	+16	0.003
+18	0.005	61	0.035	50	0.013
23	0.007	66	0.043	65	0.022
30	0.008	79	0.063	73	0.030
36	0.012	85	0.075	77	0.035
53	0.026	94	0.097	94	0.055

Perfluoroheptane

25° , 2.2 mg; 50° , 5.4 mg/100 gm. n-C₇F₁₆ (Rotariu, Fraga and Hildebrand, 1952).

Gasoline

(Data of Aldrich, 1931)

The samples of gasoline were saturated with H_2O by shaking the mixture in an evacuated bulb, provided with all the refinements for accurate removal of the saturated sample for analysis. The H_2O in this sample was determined by adding sodium-potassium alloy, free of oxide, and collecting and measuring the evolved hydrogen. The determinations were made with the greatest possible accuracy.

Gm. H₂O per 100 gms. sat. solution in Gasoline No.:

t°	10	12	13	15	19
10	0.0128	0.0051	0.0071	0.0055	0.0036
30	0.0160	0.0067	0.0086	0.0172	0.0052
50	0.0193	0.0079	0.0101	0.0208	0.0069

Gasoline sample No. 10 = Oklahoma natural gasoline,

 $d_{15} = 0.677$.

" " No. 12 = West Virginia natural gasoline,

 $d_{15} = 0.695$." " No. 13 = California Crude, $d_{15} = 0.695$." " No. 15 = Midcontinental crude, $d_{15} = 0.718$.

" " No. 19 = Oklahoma natural gasoline,

 $d_{15} = 0.682$.

H HYDROGEN

SOLUBILITY OF WATER IN VARIOUS ORGANIC SOLVENTS--Contd.

Gasoline--Contd. Using the calcium chloride method, Clifford, 1921, obtained the following values for the solubility of H₂O in gasoline of d = 0.700.

t°	Gms. H ₂ O per 100 gms. sat. solution
25	0.0085; 0.0110
35	0.0161; 0.0121
37.5	0.0175; 0.0145

The Army Air Corps, 1922, using the calcium chloride method found the solubility of water in domestic aviation gasoline at 23.9° to be 0.007 gm. H₂O per 100 gms. sat. solution.

Using the same method Uspenskii, 1929 obtained the following results:

	Gm. H ₂ O per 100 gms. sat. sol. at:	
Gasoline	10°	22°
Grozny "avis"	0.007	0.011
" grade I	0.006	0.008
" grade II	0.006	0.008
Baku grade II	0.005	0.008

(Data of Berkengeim, 1941 in aviation gasoline B-70:)

t°	-5	10	20	40
Gms. H ₂ O per 100 gms. sat. sol.	0.0011	0.0033	0.0045	0.0063

Butanol The solubility of water in butanol and benzyl alcohol was determined by Durand-Gasselin and Duclaux (1940). The effect of added electrolytes was also studied.

Essential oils Observations on the solubility of water in essential oils are given by Umney and Bunker (1912).

Butterfat (Data of Thiel, 1943)

t°	40	60	80	95
Wt. % H ₂ O	0.19%	0.26%	0.36%	0.47%

Crude Paraffin Data at 413, 473 and 573° in a crude oil of molecular weight about 345 are given by Peter and Weinert, 1955.

SOLUBILITY OF WATER IN MIXED ORGANIC SOLVENTS

WATER TOLERANCE OF MIXTURES OF GASOLINE WITH ETHYL ALCOHOL,
ISOPROPYL ALCOHOL AND BENZENE
(Bayley and Hopkins, 1934)

The mixtures contained in a test tube provided with a thermometer and a stirrer were cooled in a Dewar flask containing acetone and CO_2 snow until the cloud point was reached. The tube was then removed and the point at which the cloud just disappeared with rising temperature, was taken as the critical solution temperature. Three samples of gasoline, two of Iso propyl Alcohol and a series of samples of Ethyl Alcohol containing from 1.63 to 5.65 Volume per cent H_2O were used. Numerous diagrams showing the observed c.s.t. of various mixtures of the gasolines, alcohols and water are given. From these, various tables are constructed which show the relation of H_2O content to c.s.t. in mixtures of varying composition. Thus, for example, the critical Water Content of Mixtures containing 90, 80 and 70 per cent of regular grade automobile fuel (liquid phase cracked gasoline) is as follows.

Vol. Per Cent Composition of Mixture			Critical H_2O Content in Vol. % at:		
Gasoline	Ethyl Alcohol	Iso propyl Alcohol	0°	-20°	-40°
90	10	0	0.30	0.22	0.15
90	8	2	0.35	0.27	0.19
90	7	3	0.38	0.30	0.22
90	6	4	0.41	0.33	0.25
80	20	0	0.70	0.50	0.35
80	16	4	-	0.64	0.46
80	12	8	-	0.80	0.60
70	30	0	1.25	0.84	0.59
70	25	5	-	1.09	0.76
70	20	10	-	1.25	1.00

Iso propyl Alcohol increases the water tolerance and the critical water content of any ethyl alcohol-gasoline mixture to which it is added. Benzene may be used to increase moderately the critical water content of ethyl alcohol-gasoline mixtures by substituting benzene for part of the gasoline. Its effect, however, in increasing water tolerance appears to be too slight to be of practical value.

SOLUBILITY OF WATER IN BENZENE SOLUTIONS OF MONO, DI, AND
TRI CHLORACETIC ACIDS AT 15°
(Bell, 1930)

Results for solutions in C_6H_6 of:

CH_2ClCOOH			CHCl_2COOH			CCl_3COOH		
d of sat. sol.	Gm. Mols. per 1000 gms. sat. sol.		d of sat. sol.	Gm. Mols. per 1000 gms. sat. sol.		d of sat. sol.	Gm. Mols. per 1000 gms. sat. sol.	
	CH_2ClCOOH	H_2O		CHCl_2COOH	H_2O		CH_2ClCOOH	H_2O
0.884	0.0620	0.0329	0.880	0.035	0.0408	0.878	0.0278	0.0426
0.881	0.115	0.0423	0.880	0.071	0.055	0.878	0.0506	0.0690
0.880	0.174	0.0574	0.883	0.123	0.101	0.887	0.0950	0.115
0.885	0.217	0.0645	0.895	0.179	0.130	0.885	0.140	0.165
0.888	0.284	0.0776	0.890	0.195	0.138	0.888	0.176	0.210
0.886	0.325	0.0828				0.892	0.219	0.247
0.892	0.404	0.1000						

(Contd.)

H HYDROGEN

SOLUBILITY OF WATER IN MIXED ORGANIC SOLVENTS--Contd.

The author recalculated the results of Waddell, 1898, for benzene solutions of acetic acid at 25° and obtained the following values.

d of sat. sol.	Gm. Mols. per 1000 gms. sat. sol.	
	CH ₃ COOH	H ₂ O
0.874	0.077	0.011
0.876	0.215	0.033
0.878	0.52	0.083
0.882	0.87	0.140
0.880	1.17	0.190

SOLUBILITY OF WATER IN BENZENE SOLUTIONS OF VARIOUS ALCOHOLS (Staveley, Johns and Moore, 1951)

The original data (given in the paper) can be expressed in the form $\log_{10} N = a - 10^3 b / t^\circ + 273.1$ where N = mole fraction of water $\times 10^3$, t° = degrees centigrade. The values for the constants a and b are given as follows:

Mole Fraction Alcohol in Solvent			Mole Fraction Alcohol in Solvent			Mole Fraction Alcohol in Solvent		
a	b		a	b		a	b	
<u>Methanol - C₆H₆</u>			<u>Ethanol - C₆H₆</u>			<u>Butanol - C₆H₆</u>		
0.0113	5.219	1.416	0.00644	5.638	1.547	0.00802	5.342	1.439
.0226	5.339	1.430	.0143	5.758	1.571	.01405	4.745	1.221
.0332	5.158	1.370	.0183	5.341	1.436	.02615	3.585	0.845
.0412	5.217	1.385	.02465	4.238	1.070	.0329	3.121	0.681
.0458	4.935	1.277	.02986	3.323	0.757	.0561	2.807	0.545
.0568	4.358	1.055	.04213	3.397	0.749	.0973	2.763	0.479
.0781	3.704	0.8208	.0563	3.560	0.765			
.1047	3.504	0.7539	.0691	3.426	0.702			
<u>Pentanol - C₆H₆</u>			<u>Octanol - C₆H₆</u>					
0.00698	4.948	1.310	0.0281	2.838	0.603	0.0166	4.613	1.231
.0119	4.780	1.238	.0486	2.771	0.546	.0314	4.137	1.030
.0223	4.292	1.076	.08425	2.733	0.480	.0435	4.217	1.037

SOLUBILITY OF WATER IN BENZENE, TOLUENE AND XYLENE SOLUTIONS OF ETHANOLAMINE OLEATE (SOAP) (Pink, 1938)

The determinations were made by adding the water from a microburet to the mixtures until on active shaking a faint cloudiness appeared. The temperature is not stated but was probably that of the room. The quantity of water dissolved is proportional to the quantity of the Ethanolamine oleate (soap) present. It was also found that additions of small quantities of phenol greatly increased the amount of water dissolved. Further quantities of phenol caused the solution to become cloudy again.

SOLUBILITY OF WATER IN MIXED ORGANIC SOLVENTS--Contd.

Gm. Mols. Ethanolamine Oleate per liter organic solvent	cc H ₂ O dissolved per 50 cc of Ethanolamine Solution in		
	Benzene (C ₆ H ₆)	Toluene (C ₆ H ₅ CH ₃)	Xylene C ₆ H ₄ (CH ₃) ₂
0.05	0.18	0.17	0.18
0.10	0.38	0.34	0.36
0.20	0.70	0.68	0.69
0.30	1.06	1.05	1.08
0.40	1.40	1.32	1.36
0.50	1.70	1.68	1.68
0.60	2.08	2.03	2.07
0.70	2.35	2.34	2.36

0

Data for the solubilization of water in n-hexane, n-heptane, cyclohexane, methylcyclohexane, benzene, toluene, xylene, ethylbenzene, chlorobenzene, carbon tetrachloride, chloroform, tetrachloroethylene and bromoform by dodecylammonium chloride, formate, acetate, laurate and oleate and mixtures thereof are given by Palit and Venkateswarlu, 1954. Similar data in xylene, toluene and octadecylamine with a variety of dodecylammonium salts is reported by Palit and Venkateswarlu, 1951.

Staveley, Jeffes, and Moy (1943) give data for the solubility of water in mixtures of Benzene plus Nitrobenzene, Aniline, Dimethyl Aniline, Chloroform, Bromo Benzene, and Anisole at several temperatures and concentrations.

Kretschmer and Wiebe (1945) report the solubility of water in many mixtures of ethyl alcohol with hydrocarbons, and in mixtures of hydrocarbons which might be used as fuels.

The solubility of water in mixtures of water soluble and fat soluble organic solvents was determined by Leikola (1940).

Data for the solubility of water in 1,2 C₂H₄Cl₂ and in the ternary system C₂H₄Cl₂ - C₂H₅OH - H₂O are given by Udovenko and Fatkulina, 1952.

A review of the solubility of water in compressed N₂, H₂ and CO₂ at 50° is given by Robin and Vodar, 1953.

Results for the solubility of water in supercritical ethane at 15, 25° (30-100 atm.) are given by Diepen and Scheffer, 1950.

The mutual solubility of carbon dioxide and ethylene at 0° and pressures up to 7000 Kg/cm² has been studied by Tsiklis, 1947a.

Data for the effect of H₂O upon the Critical Solution Temperatures of mixtures of CH₃OH + CS₂, CH₃OH + n Hexane and CH₃OH + Cyclo Hexane are given by de Brouckere and Gillet, 1935. The authors used the results as the basis of a method for the determination of H₂O.

H HYDROGEN

SOLUBILITY OF WATER IN LIQUID CARBON DIOXIDE (Stone, 1943)

Liquid Carbon Dioxide and Water were rotated together in a metal tank for eight hours and then brought to equilibrium in a thermostat for 24-48 hours. The solution was then passed through a needle valve to vaporize it and the components were trapped in magnesium perchlorate and sodium-calcium hydrate and weighed. From 4 to 9 determinations were made at each temperature. See also Volume III, under Carbon Dioxide.

t°	% H ₂ O
-29	0.0195 ± 0.0011
5.08	.0639 ± 0.0020
15.0	.0900 ± 0.0027
22.6 ± 1	.104 ± 0.0078

The Solubility of Water in Phosphorus (F₄) is 3.9 ± 0.5 mg/gm. P₄ at 25° and 3.6 ± 0.3 mg/gm. P₄ at 45° (Rotariu, Haycock and Hildebrand, 1952)

O HYDROGEN PEROXIDE H₂O₂

THE SYSTEM HYDROGEN PEROXIDE - WATER

Although the various investigators agree on the freezing points of the various mixtures, the nature of the solid phases is in dispute. Maass and Herzberg (1920) reported H₂O₂, H₂O₂·2H₂O (congruently melting), and H₂O, but without analyzing the solids. Giguere and Maass (1940) redetermined the freezing points of mixtures of H₂O₂ + H₂O and found values differing by ± 2° from those found by Maass and Herzberg and in addition determined the composition of the solid phases present at various temperatures. They found that H₂O₂ and H₂O formed solid solutions throughout the entire range of compositions, and that the compound H₂O₂·2H₂O does form, and is congruently melting, but it divides the phase diagram into two roughly symmetrical halves; e.g. it forms a discontinuous solid solution with each of the components. Mixtures were made from which the solid was separated, and the composition of both solid and liquid determined, as well as the respective melting and freezing points. Foley and Giguere (1951) reiterate that solid solutions are present, and by the use of radioactive tracers estimate that the solid solutions lie between 10-90% H₂O₂.

Kubaschewski and Weber (1950) support these findings with freezing point measurements indicating solid solutions between 25-90% H₂O₂.

The System was reinvestigated by Mironov and Bergman (1951) and by Mironov (1955) who found no solid solutions at all. The same eutectic halt was observed at all compositions from the pure component (H₂O₂ or H₂O) to the composition of the double compound and no polymorphic transitions were found. Giguere and Secco (1954) apparently agree tacitly with these later findings, because they draw the diagrams of both the H₂O₂ + H₂O and D₂O₂ - D₂O systems without indication of solid solutions.

(Contd.)

DATA OF GIGUERE AND MAASS, 1940

t° (F. pt. of Liq.)	Gms. H ₂ O ₂ per 100 gms.		Solid Phase
	Liquid	*Solid	
- 2.2	4.5	1.0	S.S. I
- 4.4	8.1	2.0	"
- 6.1	9.9	3.5	"
- 9.2	14.5	5.5	"
-11.7	17.6	8.5	"
-16.2	22.2	12.5	"
-18.5	24.0	14.3	"
-22.2	27.7	17.5	"
-25.1	30.0	19.5	"
-27.4	31.4	20.6	"
-30.3	33.8	22.0	"
-33.5	36.6	25.5	"
-44.5	42.0	29.1	"
-50.8	44.7	31.5	"
-51.1	46.0	31.6	"
-51.5	45.0*	31.7	S.S. I + S.S. II
-50.2	48.0	-	S.S. II
-50.3	48.6	48.6	H ₂ O ₂ ·2H ₂ O
-50.5	51.1	-	S.S. III
-51.5	54.0	51.5	"
-52.2	56.3	52.5	"
-53.6	58.2	54.5	"
-54.0	60.2	55.5	"
-56.5	60.0*	57.5-85.2	S.S. III + S.S. IV
-50.0	63.5	85.6	S.S. IV
-43.5	68.0	86.5	"
-39.7	70.1	87.2	"
-30.4	76.0	89.5	"
-26.3	78.2	90.5	"
-22.2	80.5	92.1	"
-17.4	85.3	94.0	"
-11.2	90.1	97.0	"
- 0.89†	100.0	-	H ₂ O ₂

S.S. I - Solid Solution of H₂O₂·2H₂O in H₂O
 S.S. II - " " " H₂O in H₂O₂·2H₂O
 S.S. III - " " " H₂O₂ in H₂O₂·2H₂O
 S.S. IV - " " " H₂O₂·2H₂O in H₂O₂

*Read from graph

†Maass, Cuthbertson, and Matheson, 1928.

(Contd.)

H HYDROGEN

DATA OF MIRONOV, 1955

Wt. % H ₂ O ₂ in Solution	t°		Solid Phase	Wt. % H ₂ O ₂ in Solution	t°		Solid Phase
	Initial Cryst.	Eutectic Halt			Initial Cryst.	Eutectic Halt	
0.0	0.0	(m.pt.)	H ₂ O	63.4	-48.1	-55.4	H ₂ O ₂
1.0	- 0.4	-52.4	"	65.3	-43.4	-	"
3.5	- 2.3	-52.1	"	66.4	-42.7	-	"
10.1	- 7.0	-	"	68.5	-39.4	-	"
13.4	- 9.8	-	"	69.2	-38.5	-54.7	"
18.0	-13.2	-	"	71.7	-35.0	-	"
22.4	-17.0	-51.4	"	74.2	-31.8	-56.0	"
29.5	-25.4	-50.9	"	74.6	-30.8	-	"
34.8	-31.9	-	"	76.5	-28.5	-	"
39.8	-39.8	-52.4	"	77.0	-27.4	-56.0	"
43.7	-47.3	-	"	79.2	-25.0	-	"
45.7	-51.7	-	"	80.1	-23.2	-	"
46.5	-51.7	-52.5	H ₂ O ₂ ·2H ₂ O	82.8	-19.4	-	"
48.6	-50.2	(m.pt.)	"	85.7	-15.6	-	"
48.8	-50.8	(m.pt.)	"	92.5	- 7.6	-	"
50.2	-50.2	-55.8	"	94.0	- 6.0	-55.9	"
51.1	-50.7	-	"	95.2	- 4.9	-55.0	"
55.5	-52.1	-55.6	"	97.4	- 3.4	-55.3	"
58.9	-54.7	-	"	99.3	- 0.3	-56.0	"
60.8	-54.7	-	H ₂ O ₂	99.8	- 0.2	-57.4	"

The partial pressures of H₂O and H₂O₂ over mixtures of the two at 30°, 45°, and 60° are reported by Giguere and Maass (1940a).

THE SYSTEM D₂O₂ - D₂O
(Giguere and Secco, 1954)

Wt. % D ₂ O ₂	Freezing Pt.	Eutectic Halt	Solid Phase	Wt. % D ₂ O ₂	Freezing Pt.	Eutectic Halt	Solid Phase
0.0	+ 3.80	-	D ₂ O	48.8	-51.5	-	1:2
11.0	- 3.4	-	"	50.3	-51.6	-	"
20.6	-11.6	-	"	56.0	-53.3	-55.1	"
30.5	-22.3	-	"	60.5	-55.1	-	1:2 + D ₂ O
38.5	-35.4	-	"	61.2	-	-55.0	D ₂ O
43.5	-45.0	-	"	66.6	-43.8	-	"
44.7	-47.0	-51.3	"	77.5	-25.8	-	"
45.8	-50.1	-51.3	"	80.8	-21.0	-	"
46.2	-51.5	-	D ₂ O + 1:2	95.0	- 4.3	-	"
46.5	-51.5	(m.pt.)	1:2	95.9	- 3.1	-	"
47.0	-51.6	-	"				

1:2 = D₂O₂·2D₂O

DISTRIBUTION OF HYDROGEN PEROXIDE BETWEEN WATER AND ETHYL ETHER AT 18°
(Results of de Kolossovsky, 1919, 1925)

The mixtures of equal volumes of water and ether, to which different amounts of redistilled - Perhydrol - were added, were vigorously shaken during 20 minutes, by periods of 2 minutes each, and allowed to stand in the thermostat between the agitations and for 1 hour after the last. Aliquot portions of each layer were titrated with aqueous KMnO_4 solution in presence of sulfuric acid. The determinations were plotted and the following results were obtained from the curve.

Gms. H_2O_2 per 100 cc			Gms. H_2O_2 per 100 cc		
H_2O	$(\text{C}_2\text{H}_5)_2\text{O}$	$\frac{P}{P_1}$	H_2O	$(\text{C}_2\text{H}_5)_2\text{O}$	$\frac{P}{P_1}$
layer (p)	layer (P_1)		layer (p)	layer (P_1)	
0.935	0.065	14.4	17.908	2.092	8.6
2.795	0.205	13.6	19.590	2.410	8.1
4.640	0.360	12.9	21.251	2.749	7.7
6.470	0.530	12.2	23.707	3.293	7.2
9.182	0.818	11.2	25.324	3.676	6.9
10.968	1.034	10.6	26.929	4.071	6.6
12.734	1.266	10.1	28.522	4.478	6.4
14.479	1.521	9.5	30.119	4.881	6.2
16.204	1.796	9.0	31.714	5.286	6.0

DISTRIBUTION OF HYDROGEN PEROXIDE BETWEEN VARIOUS AQUEOUS
SOLUTIONS AND AMYL ALCOHOL

Water + Amyl Alcohol
(Calvert, 1901; Joyner, 1912)

Results at 0°. (Calvert, Joyner)

Results at 25°. (Calvert)

Mols. H_2O_2 per Liter			Mols. H_2O_2 per Liter		
H_2O	Alcohol	$\frac{W}{A}$	H_2O	Alcohol	$\frac{W}{A}$
layer (W)	Layer (A)		Layer (W)	Layer (A)	
0.146	0.0216	6.76	0.094	0.013	7.01
0.200	0.030	6.66	0.194	0.028	6.91
0.407	0.061	6.63	0.297	0.042	7.08
0.749	0.113	6.66	0.670	0.095	7.09
1.970	0.293	6.71	0.913	0.130	7.01

(Results of Menzel, 1923 at 0°)

Cc 0.05n Thiosulfate solution
required for 10 cc of

Cc 0.05n Thiosulfate solution
required for 10 cc of

Aq.	Alcoholic	$\frac{W}{A}$	Aq.	Alcoholic	$\frac{W}{A}$
Layer (W)	Layer (A)		Layer (W)	Layer (A)	
32.05	4.60	6.97	52.95	7.70	6.88
36.50	5.27	6.96	59.15	8.60	6.88
43.83	6.36	6.89	68.00	10.05	6.80
46.50	6.70	6.94	76.25	11.23	6.79
52.85	7.73	6.85			

N HYDROGEN

The following results for the distribution of hydrogen peroxide between water and Iso amyl alcohol (b.pt. 128°-130°) at 0° are given by Husain, 1927, but the terms in which the concentrations are expressed are not stated.

Conc. of H ₂ O ₂ in H ₂ O(W)	Conc. of H ₂ O ₂ in Alcohol (A)	$\frac{W}{A}$
26.90	4.10	6.56
32.12	4.93	6.53

Other aqueous solutions + Amyl alcohol:

- Aq. Sodium and potassium phosphates + amyl alcohol at 0° (Husain, 1927)
 Aq. Sodium hydroxide + amyl alcohol at 0°, 25° (Calvert, 1901)
 Aq. Potassium meta and tetraborate + amyl alcohol at 0° (Menzel, 1923)

DISTRIBUTION OF HYDROGEN PEROXIDE BETWEEN WATER AND VARIOUS ORGANIC SOLVENTS (Data of Walton and Lewis, 1916)

Different amounts of perhydrol (30% H₂O₂ solution) were added to various mixtures of water and organic solvents and, after constant agitation for about 1 hour, the H₂O₂ in each layer was determined.

Solvent	t°	Ratio $\frac{\text{Conc. aq.}}{\text{Conc. Org. Solvent}}$	Solvent	t°	Ratio $\frac{\text{Conc. aq.}}{\text{Conc. Org. Solvent}}$
Ethyl Acetate	25	3.92- 4.11	Methyl Iodide	25	Approx. 200
Isobutyl Alcohol	25	2.58- 2.63	m Toluidine	25	Approx. 5
Amyl Acetate	25	13 -13.2	Phenol	25	4.35 -5.55
Acetophenone	25	5.82- 6.06	Quinoline	0	0.276-0.391
Ether	25	8.28- 9.11	"	25	0.365-0.642
Ether	0	5.72- 5.85	"	40	0.516-0.602
Aniline	25	4.08- 4.10			

The following approximate values, determined at room temp., are quoted from the dissertation of A. Braun, Univ., Wisconsin, 1914.

Solvent	Ratio: $\left[\frac{\text{Conc. aq.}}{\text{Conc. Org. Solvent}} \right]$	Solvent	Ratio: $\left[\frac{\text{Conc. aq.}}{\text{Conc. Org. Solvent}} \right]$
Ethyl Acetate	$\frac{1}{3}$	Chloroform	$\frac{1}{600}$
Nitrobenzene	$\frac{1}{200}$	Benzene	$\frac{1}{200}$
Acetophenone	$\frac{1}{2}$	Isobutyl Alcohol	$\frac{1}{3}$
Amyl Acetate	$\frac{1}{3}$	Propyl Formate	$\frac{1}{3}$
Ethylisovalerianate	$\frac{1}{20}$	Isobutyl Butyrate	$\frac{1}{50}$
Isoamyl Propionate	$\frac{1}{12}$	Propyl Butyrate	$\frac{1}{50}$

(Contd.)

(Data of Shanley and Greenspan, 1947 at room temperature)

Solvent	Gms. 90% H_2O_2 per 100 gms. Solvent
Methyl Methacrylate	18
Di Methyl Phthalate	28
Di Ethyl Phthalate	2.5
Allyl CR-39 Monomer	28

Ethyl Acetate and Aniline are miscible with 90% H_2O_2 in all proportions.

FREEZING-POINTS OF MIXTURES OF HYDROGEN PEROXIDE AND METHYL ALCOHOL
(Matheson and Maass, 1929)

t^*	Gm. Mol. CH_3OH per 100 gm. mols. $\text{CH}_3\text{OH} + \text{H}_2\text{O}_2$	Solid Phase	t^*	Gm. Mol. CH_3OH per 100 gm. mols. $\text{CH}_3\text{OH} + \text{H}_2\text{O}_2$	Solid Phase
- 1.7	5.6	H_2O_2	-18.6	28.3	H_2O_2
- 6.4	13.2	"	-22.2	33.2	"
-10.2	18.4	"	-37.8	43.8	"
-15.3	25.2	"	-49.3	51.5	"

The authors also give results for the freezing-points of mixtures of hydrogen peroxide and each of the following compounds: Ethyl Ether, Piperidine, Diethyl amine, Mono *n* Butylamine, Tertiary mono Butylamine, Di iso Butylamine, Tripropylamine and Dimethyl amine.

THE SYSTEM HYDROGEN PEROXIDE - UREA - WATER
(Janecke, 1932)

To aqueous hydrogen peroxide solutions of known concentrations weighed amounts of urea were added and the mixtures warmed until clear. Upon cooling the temperature was determined at which crystals separated. The Solid Phases were ice, urea or the double compound $\text{CO}(\text{NH}_2)_2 \cdot \text{H}_2\text{O}_2$.

Temp. of Saturation of Solution containing:

Wt. % H_2O_2 in Aqueous Solvent	10 Wt. % $\text{CO}(\text{NH}_2)_2$	20 Wt. % $\text{CO}(\text{NH}_2)_2$	30 Wt. % $\text{CO}(\text{NH}_2)_2$	40 Wt. % $\text{CO}(\text{NH}_2)_2$	50 Wt. % $\text{CO}(\text{NH}_2)_2$	60 Wt. % $\text{CO}(\text{NH}_2)_2$
3.0	-5.0	- 6.5	- 9.7	- 0.8	+16.5	+35.0
6.0	-6.0	- 7.5	- 2.0	+ 6.0	+12.2	+20.3
10.0	-8.0	- 2.0	+ 3.3	+ 5.5	+14.0	+34.5
15.0	-3.0	+ 6.0	+11.6	+13.5	+15.2	+32.0
20.0	+2.7	+12.2	+19.2	+21.0	+22.5	+31.5
30.0	+7.0	+20.3	+27.5	+32.0	+34.5	+34.4

Temp. of Saturation of Solution containing:

Wt. % H_2O_2 in Aqueous Solvent	5 Wt. % $\text{CO}(\text{NH}_2)_2$	10 Wt. % $\text{CO}(\text{NH}_2)_2$	15 Wt. % $\text{CO}(\text{NH}_2)_2$	20 Wt. % $\text{CO}(\text{NH}_2)_2$	25 Wt. % $\text{CO}(\text{NH}_2)_2$	33.7 Wt. % $\text{CO}(\text{NH}_2)_2$	43.7 Wt. % $\text{CO}(\text{NH}_2)_2$
36.0	- 1.0	+12.0	+20.0	+25.0	+30.5	+36.0	+40.5
47.7	0.0	+15.0	+25.0	+31.0	+38.0	-	-
59.9	+ 2.0	+11.0	+22.5	+33.0	-	-	-
79.1	- 8.0	+12.5	+26.0	+35.5	+47.5	-	-
91.8	-20.0	+ 4.0	+20.0	+31.5	+45.0	-	-

H HYDROGEN

Freezing-point data have been determined for mixtures of:

$H_2O_2 + KCl$	(Matheson and Maass, 1929)
" + K_2SO_4	"
" + NaF	"
" + H_2SO_4	"
" + NH_3	(Maass and Hatcher, 1922)
" + $NaCl$	"
" + $NaNO_3$	"

P PHOSPHINE PH_3

2.856 ml. PH_3 (26°, 766 mm.) dissolve in one liter of cyclohexanol. (Cauquil, 1927)

PO HYPOPHOSPHORIC ACID H_2PO_3

100 gms. sat. solution in water contain 81.8 gms. H_2PO_3 at the m.pt., 62°, of the hydrated compound, $H_2PO_3 \cdot H_2O$. (Rosenheim and Pritze, 1908)

PO PHOSPHOROUS ACID H_3PO_3

FREEZING POINTS IN THE SYSTEM PHOSPHOROUS ACID - DIOXANE (Mezhenni, 1949)

Mole % Dioxane	Freezing Point°	Solid Phase	Mole % Dioxane	Freezing Point°	Solid Phase
100.0	11.78	D	66.51	6.61	D
98.8	11.32	D	63.75	6.0	D
97.25	11.25	D	63.50	4.0	D
92.5	10.36	D	63.50	-1.5	D
90.8	10.11	D	55.58	-2	D
89.0	9.79	D	53.79	-5	D + P
86.1	9.35	D	53.49	-4	P
84.2	9.19	D	47.8	11.5	P
83.60	9.68	D	39.9	3.7	P
83.25	8.31	D	29.98	22.5	P
79.01	8.99	D	22.2	36.1	P
75.42	8.11	D	20.79	41.0	P
75.03	7.92	D	16.42	49	P
74.20	7.32	D	12.56	56.1	P
73.10	7.92	D	0.0	72.31	P
69.99	6.8	D			

Freezing-point data are given by Redfield and King, 1936, for each of the following systems:

$H_3PO_3 + CH_3COOH$	(Acetic Acid)
" + CCl_3COOH	(Trichloro Acetic Acid)
" + $CH_3COCOOH$	(Pyruvic acid)
" + C_6H_5COOH	(Phenol)
" + $C_6H_5COCH_3$	(Acetophenone)
" + $(CH_2O_2)C_6H_5CHO$	(Piperonal)
" + $C_6H_5CH:CH:OCO$	(Coumarin)

Ortho PHOSPHORIC ACID H_3PO_4

PO

THE SYSTEM $\text{H}_3\text{PO}_4 - \text{H}_2\text{O}$

The data of Ross and Jones (1925) and Smith and Menzies (1909) are similar. Ross and Jones did not find the 10:1 hydrate reported by the earlier workers.

(Data of Ross and Jones, 1925)

t°	Gms. H_3PO_4 per 100 gms. sat. sol.	Solid Phase
- 5	17.5	Ice
-10	27.0	"
-15	34.0	"
-20	38.0	"
-25	42.0	"
-35	47.5	"
-45	51.0	"
-60	55.0	"
-75	59.5	"
-85 (Eutec.)	62.5	Ice + 2 $\text{H}_3\text{PO}_4 \cdot \text{H}_2\text{O}$
-57	67.0	$2\text{H}_3\text{PO}_4 \cdot \text{H}_2\text{O}$
-43	70.0	"
-29.0	72.5	"
-17.5	75.0	"
0.0	78.75	"
18.92	84.07	"
23.41	85.93	"
25.24	87.05	"
27.30	88.51	"
28.75	90.00	"
29.32 m. pt.	91.60	"
28.80	92.30	"
28.28	92.72	"
27.36	93.33	"
26.08	93.74	"
23.50 (Eutec.)	94.75	" + H_3PO_4
25.88	95.22	H_3PO_4
27.30	95.56	"
28.38	95.86	"
29.90	96.18	"
31.96	96.80	"
34.06	97.40	"
36.15	98.00	"
40.02	99.27	"
42.35 m. pt.	100.00	"

*100 gms. sat. solution of $2\text{H}_3\text{PO}_4 \cdot \text{H}_2\text{O}$ in water contain 85.95 gms. H_3PO_4 at 25°. (Grube and Staesche, 1927.)

(Contd.)

H HYDROGEN

(Data of Smith and Menzies, 1909)

t°	Gms. H ₃ PO ₄ per 100 Gms.		Solid Phase	t°	Gms. H ₃ PO ₄ per 100 Gms.		Solid Phase
	Sat. Sol.				Sat. Sol.		
-81*	62.9		Ice + 2H ₃ PO ₄ ·H ₂ O	24.38	94.80		10H ₃ PO ₄ ·H ₂ O
-16.3	76.7		2H ₃ PO ₄ ·H ₂ O	24.40	94.84		"
+ 0.5	78.7		"	24.81	94.95		"
14.95	81.7		"	25.41	95.26		"
24.03	85.7		"	25.85	95.54		"
27.00	87.7		"	26.2*	...		" + H ₃ PO ₄
29.15	90.5		"	26.23	95.90		H ₃ PO ₄
29.35†	91.6		"	27.02	95.98		"
28.5	92.5		"	29.42	96.15		"
27.0	93.4		"	29.77	96.11		"
25.4	94.1		"	37.65	97.80		"
23.5*	...		" + 10H ₃ PO ₄ ·H ₂ O	39.35	98.48		"
24.11	94.78		10H ₃ PO ₄ ·H ₂ O	42.30†	100		"

*Eutec.

†M. pt.

SOLUBILITY OF ORTHO PHOSPHORIC ACID IN ETHYL ETHER
(Rabinowitsch and Jakubsohn, 1923)

t*	Gms. H ₃ PO ₄ per 100 gms. sat. sol.	Solid Phase
14.0	82.50	4H ₃ PO ₄ (C ₂ H ₅) ₂ O
17.2	83.48	"
29.3 (m. pt.)	84.20	"
30.0	84.38	"
28.4	84.96	"
27.5	87.00	"
25.2	87.48	"
23.9	87.70	"
22.0 (Eutec.)	-	" + 6H ₃ PO ₄ (C ₂ H ₅) ₂ O
24.5	88.05	6H ₃ PO ₄ (C ₂ H ₅) ₂ O
25.2	88.10	"
28.2 (m. pt.)	88.80	"
27.5	88.94	"
25.5	89.10	"
22.1	89.50	"
17.5	89.85	"
16.0 (Eutec.)	90.10	" + H ₃ PO ₄
16.9	91.7	H ₃ PO ₄
17.7	92.5	"
21.0	95.10	"
23.4	96.17	"
26.5	97.20	"
28.3	97.85	"
28.7	97.93	"
30.1	98.50	"
38.4	100.00	"

The system H₃PO₄ - (C₂H₅)₂O - H₂O was studied at 0° by Ust-Kachkintsev and Khlebnikov, 1939.

EXTRACTION OF H_3PO_4 BY ETHYL ETHER AT ROOM TEMPERATURE
(Helfrich and Baumann, 1952)

50 cc of absolute ether were shaken with 2 cc of phosphoric acid solution of the strength indicated.

Initial % H_3PO_4 :	20.5	38	64	82.5
Gms. per 50 cc ether:				
H_3PO_4	0.15	0.30	0.98	9.87
H_2O	1.58	1.16	0.60	2.09

THE SYSTEM PHOSPHORIC ACID - PHENOL - WATER
(Krupatkin, 1952)

The system exhibits a closed ternary miscibility gap. The data were obtained from series of mixture containing fixed amounts of H_3PO_4 . PO

t°	% Phenol in		t°	% Phenol in		t°	% Phenol in	
	Phase 1	Phase 2		Phase 1	Phase 2		Phase 1	Phase 2
	0 % H_3PO_4			5% H_3PO_4			10% H_3PO_4	
	[Binary System H_3PO_4 - Phenol]							
100.5	68.00	68.00	41.0	7.57	-	23.0	-	94.71
101.0	70.82	64.92	49.0	-	-	49.0	7.15	-
101.5	-	62.44	57.5	9.96	-	64.0	-	91.21
103.5	76.33	-	75.0	-	84.91	76.0	11.20	-
104.0	-	57.93	79.0	19.79	-	88.0	15.56	-
106.5	80.05	-	84.0	27.11	-	97.0	24.80	-
108.5	-	49.54	87.0	39.17	-	102.0	34.96	-
114.0	-	39.55	90.0	56.06	-	108.0	45.32	-
115.0	84.61	-	92.0	-	81.35	110.0	-	85.97
118.0	-	29.15	92.5	70.66	-	114.5	54.48	-
121.5	-	19.64	94.5	75.05	-	125.0	63.92	-
129.0	89.86	-	95.0	-	78.76	129.0	74.05	-
						130.0	-	81.33
	20% H_3PO_4			30% H_3PO_4			50% H_3PO_4	
44.0	5.60	-	39.0	3.26	-			
50.0	-	94.50	60.0	-	95.18	49.0	2.33	-
74.0	6.73	-	69.0	4.51	-	52.0	-	96.02
80.0	-	93.53	78.0	5.11	-	80.0	-	95.59
94.0	9.53	-	81.0	-	94.46	92.0	3.28	-
107.5	13.31	-	102.0	7.34	93.15	98.0	-	94.72
109.0	-	90.78	116.0	-	91.54	110.0	4.04	-
117.5	-	89.46	122.0	9.92	-	117.0	-	93.52
123.0	20.23	-				126.0	5.53	-
	70% H_3PO_4			85% H_3PO_4				
56.0	-	96.04	55.0	-	95.98			
71.0	2.03	-	72.0	1.96	95.46			
74.0	-	95.77	93.0	2.35	-			
90.0	-	95.51	110.0	-	94.59			
99.0	2.48	-	115.0	2.74	-			
114.0	3.11	-	120.0	3.04	-			
123.0	3.60	-	130.0	-	94.03			
128.0	-	94.87						

H HYDROGEN

THE SYSTEM PHOSPHORIC ACID - DIOXANE (Mezhenni, 1949)

Mole % dioxane	Freezing pt. °	Mole % dioxane	Freezing pt. °	Mole % dioxane	Freezing pt. °	Mole % dioxane	Freezing pt. °
100.0	11.78	84.2	9.19	63.50	4.0	29.98	22.5†
98.8	11.32	83.25	8.31	63.50	-1.5	22.2	36 †
92.5	10.36	75.03	7.92	55.58	-2	20.79	41 †
90.8	10.11	74.20	7.34	53.79	-5	16.42	49 †
89.0	9.79	69.99	6.8	47.0	-13.5*	12.56	56.1†
86.1	9.35	63.75	6.0	39.9	+ 3.7 †	0.0	72.1†

* = Eutectic

† = Solid phase H_3PO_4 , solid phase dioxane in all other cases.

Freezing-point data are given by King and Walton, 1931, for each of the following mixtures:

H_3PO_4 + CH_3COOH (acetic acid)	H_3PO_4 + C_6H_5CHO (Benzaldehyde)
" + C_2H_5COOH (Propionic acid)	" + $CH_3OC_6H_4CHO$ (Anisaldehyde)
" + C_3H_7COOH (n Butyric acid)	" + $C_6H_5COCH_3$ (Acetophenone)
" + $CH_3(CH_2)_4COOH$ (n Caproic acid)	" + $C_6H_5COC_6H_5$ (Benzo aceto phenone)
" + C_6H_5COOH (Benzoid acid)	" + C_6H_5OH (Phenol)
" + $CH_3COCOOH$ (Pyruvic acid)	" + $C_6H_4OH \cdot OCH_3$ (Guaiacol)
" + $CH_2ClCOOH$ (Monochloro acetic acid)	" + $C_6H_4CH:CH \cdot OC_6H_4$ (Cumarin)
" + $CH_2C_6H_5COOH$ (Phenyl acetic acid)	

F.p.t. data for mixtures of phosphoric and phosphorus acids are given by Rosenheim, Stadler and Jakobsch (1906).

PO Pyro PHOSPHORIC ACID $H_4P_2O_7$

SOLUBILITY IN WATER (Giran, 1908)

[It should be noted that in the case of H_3PO_4 , Giran's freezing points were shown to be inaccurate because of supersaturation.]

t °	Gms. $H_4P_2O_7$ per 100 Gms. Sat. Sol.	Solid Phase
-75	59	Ice + $H_4P_2O_7 \cdot 1\frac{1}{2}H_2O$
+26 m. pt.	86.8	$H_4P_2O_7 \cdot 1\frac{1}{2}H_2O$
23	88.8	" + $H_4P_2O_7$
61 m. pt.	100	$H_4P_2O_7$

Leuteo PHOSPHOMOLYBDIC ACID $H_{12}[P_2O_2(Mo_2O_7)_9] \cdot xH_2O$

Solubility data in water from the eutectic (-31°) to the decomposition point (+35°) were determined by Nikitina and Sokolova, 1954. 33-, 36- and 39-hydrates are reported. Data for the ammonium salt: $(NH_4)_6H_6[P_2O_2(Mo_2O_7)_9] \cdot 28H_2O$ are given from 0°-45°.

PERRHENIC ACID HReO_4

ReO

Data for the partition of HReO_4 and other perrhenates between water and nitromethane at 25° are given by Friedman and Haugen, 1954.

HYDROGEN SULFIDE H_2S

S

SOLUBILITY IN WATER
(Winkler, 1906, 1912)

Abs. Coef β shows the vol. of H_2S (reduced to 0° and 760 mm) absorbed by 1 vol. of H_2O when the pressure of the gas without the tension of the liquid amounts to 760 mm.

q is the weight of H_2S in grams which is taken up by 100 grams of H_2O at the given temperature and total pressure (partial pressure of gas + vapor pressure of the liquid) is 760 mm.

The older data of Bunsen and Carius agree at about 10° but show a smaller change in solubility with temperature.

t°	Abs. Coef. β	q	t°	Abs. Coef. β	q	t°	Abs. Coef. β	q
0	4.621	0.699	25	2.257	0.334	60	1.176	0.146
5	3.935	0.593	30	2.014	0.295	70	1.010	0.109
10	3.362	0.505	35	1.811	0.262	80	0.906	0.076
15	2.913	0.436	40	1.642	0.233	90	0.835	0.041
20	2.554	0.380	50	1.376	0.186	100	0.800	0

THE SOLUBILITY OF HYDROGEN SULFIDE IN WATER AS MEASURED BY THE
VAPOR PRESSURES OF THE SOLUTIONS
(Wright and Maass, 1932)

A new type of glass diaphragm manometer was used for determination of the equilibrium pressures of known mixtures of $\text{H}_2\text{S} + \text{H}_2\text{O}$, confined in an all glass cell. This obviated stray reactions between the gas and Hg or stopcock grease. The results show that Henry's Law is not strictly obeyed.

t°	Pressure in mm. Hg		Gm. Mols. H_2S per liter of		Partition Coef. s/v
	Total	Partial	Vapor Phase (v)	Aq. Solution (s)	
5	274.5	268.0	0.0155	0.0635	4.09
"	560.0	553.0	0.0321	0.1302	4.06
"	838.0	831.0	0.0484	0.1910	3.94
"	1176.0	1169.0	0.0685	0.2682	3.92
10	303.8	294.7	0.0168	0.0597	3.56
"	615	606	0.0346	0.1220	3.52
"	914	905	0.0518	0.1801	3.47
"	1279	1270	0.0731	0.2511	3.44
"	1567	1558	0.0900	0.3060	3.40
"	2112	2103	0.1221	0.4099	3.36

(Contd.)

H HYDROGEN

THE SOLUBILITY OF HYDROGEN SULFIDE IN WATER AS MEASURED BY THE
VAPOR PRESSURES OF THE SOLUTIONS--Contd.

t°	Pressure in mm. Hg		Gm. Mols. H ₂ S per liter of		Partition Coef. s/v
	Total	Partial	Vapor Phase (v)	Aq. Solution (s)	
20	362.8	345.4	0.0190	0.0528	2.78
"	724	707	0.0390	0.1074	2.76
"	1067	1050	0.0581	0.1594	2.274
"	1483	1466	0.0816	0.2188	2.68
"	1817	1800	0.1005	0.2696	2.68
"	2454	2437	0.1371	0.3642	2.66
30	422.8	391.3	0.0208	0.0470	2.26
"	830	798	0.0425	0.0955	2.25
"	1219	1187	0.0636	0.1413	2.22
"	1674	1640	0.0882	0.1932	2.19
"	2052	2020	0.1091	0.2398	2.20
"	2785	2753	0.1498	0.3247	2.17
40	486.5	431.6	0.0222	0.0426	1.92
"	934	879	0.0454	0.0858	1.89
"	1370	1315	0.0682	0.1260	1.85
"	1853	1798	0.0937	0.1722	1.84
"	2278	2223	0.1162	0.2149	1.85
"	3095	3040	0.1603	0.2921	1.82
60	652.2	503.3	0.0243	0.0359	1.48
"	1162	1013	0.0492	0.0730	1.48
"	1681	1532	0.0747	0.1045	1.40
"	2213	2064	0.1010	0.1440	1.42
"	2731	2582	0.1269	0.1777	1.40
"	3707	3558	0.1762	0.2426	1.38

A detailed study of the phase equilibria in the system H₂S - H₂O from 0° - 210° F. and 6-5000 psi is given by Selleck, Carmichael and Sage (1952). Earlier data are given by Sheffer, 1911 and by de Forcrand (1888).

At 25° liquid H₂S and H₂O from two phases containing 4.0 and 99.49% H₂S respectively. (Mannheimer, 1956).

SOLUBILITY OF HYDROGEN SULFIDE IN AQUEOUS SOLUTIONS OF
HYDROCHLORIC ACID AT 25°

(Data of Kendall and Andrews, 1921)

Normality of aq. HCl solutions	Gm. mols. H ₂ S per liter sat. sol.	Cc H ₂ S (at 0° and 760mm) dissolved by 1 cc sat. sol. (at 760 mm. pressure)
0.0 (= H ₂ O)	0.1023	2.266
0.1348	0.1018	2.253
0.2828	0.1015	2.247
0.6308	0.1016	2.250
1.180	0.1020	2.260
1.848	0.1026	2.272
2.498	0.1030	2.281
3.040	0.1034	2.291
3.308	0.1039	2.301
4.410	0.1076	2.384
4.874	0.1090 (Contd.)	2.413

(Data of Kapustinsky and Anvaer, 1941)
at higher acid concentrations

Hydrochloric Acid			Hydrogen Sulfide		
Wt. %	Gm. Moles per liter of Solution	Gm. Moles per 1000 gms. of Water	Gm. Moles per liter of Solution (P.P.=760 mm)	Gm. Moles per 1000 gms. of Water	
				(P.P.=760 mm)	(Total Pressure=760 mm)
0.0			0.1013	0.1227	0.1200
16.8	5.0	5.55	.1098	0.1227	0.1200
20.2	6.1	7.0	.1124	.1291	.1266
23.7	7.3	8.4	.1165	.1375	.1351
28.1	8.8	10.7	.1192	.1462	.1437
34.9	11.4	14.7	.1169	.1542	.1319
*36.5		15.7		.16	.125
*37.7		16.6		.165	.11
*39.0		17.5		.17	.08
*40.3		18.5		.175	.045
*41.5		19.4		.18	.00

*Extrapolated Values

SOLUBILITY OF H_2S IN HCl SOLUTIONS CONTAINING $ZnCl_2$ AND $FeCl_2$ AT 25°
(Kapustinsky and Anvaer, 1941)

- ZnCl ₂ -				- FeCl ₂ -			
Total P. mm.	Gm. Moles per 1000 gms. H ₂ O			Total P. mm.	Gm. Moles per 1000 gms. H ₂ O		
	HCl	ZnCl ₂	H ₂ S		HCl	FeCl ₂	H ₂ S
7.60	3.9	2.1	0.1157	7.60	1.6	0.9	0.085
7.58	5.0	4.7	.1501	7.60	3.4	1.0	.089
7.55	7.8	1.0	.1345	7.60	7.8	1.1	.108
7.46	9.1	1.5	.1433	7.60	10.6	1.2	.120
7.45	10.6	1.1	.1495	7.60	9	Saturated (less than 20%)	
7.50	13.5	0.8	.1416				

SOLUBILITY OF HYDROGEN SULFIDE IN AQUEOUS SOLUTIONS OF HYDRIODIC ACID AT 25° AND 760 mm. TOTAL PRESSURE
(Pollitzer, 1909)

Mols. per Liter			Gms. per Liter		Mols per Liter			Gms. per Liter	
(H^+)	(HI)	(H_2S)	HI	H_2S	(H^+)	(HI)	(H_2S)	HI	H_2S
0.20	0	0.1040	0	3.54	4.71	4.38	0.163	560.4	5.55
1.23	1.01	0.111	129.2	3.78	5.33	5.005	0.165	640.3	5.62
1.74	1.51	0.113	193.2	3.85	6.06	5.695	0.181	728.6	6.17
2.18	1.93	0.125	246.9	4.26	7.33	6.935	0.197	887.2	6.71
2.92	2.64	0.138	337.8	4.70	9.75	9.21	0.267	1179	9.10
3.71	3.42	0.142	437.5	4.84					

N HYDROGEN

SOLUBILITY OF HYDROGEN SULFIDE IN SODIUM BISULFIDE SOLUTIONS (Goldschmidt and Larson, 1910)

t°	Moles per liter		t°	Moles per liter	
	NaSH	H ₂ S		NaSH	H ₂ S
15	0.1	0.132	35	0.05	0.082
	.2	.129		.1	.082
25	.1	.104	45	.05	.064
	.2	.1035			

Data for the solubility of H₂S in Na₂CO₃ + NaHCO₃ + NaHS solutions (20°-65°, 50-3500 mm) are given by Mai, 1955.

S

SOLUBILITY OF HYDROGEN SULFIDE IN VARIOUS AQUEOUS SALT SOLUTIONS AT 25° (McLauchlan, 1903)

[also glycerin, ethanol, acetic, tartaric, hydrochloric, and sulfuric acids]

Note:- The original results are given in terms of $\frac{l}{l_0}$ which is the iodine titer (l) of the H₂S dissolved in the salt solution, divided by the titer (l_0), of the H₂S dissolved in pure water. These figures were multiplied by 2.61 and the products recorded in the following table as volumes of H₂S absorbed by 1 vol. of aqueous solution.

Solution	Gms. Salt per Liter	$\frac{l}{l_0}$	Vols. H ₂ S per l Vol. Sol.	Solution	Gms. Salt per Liter	$\frac{l}{l_0}$	Vols. H ₂ S per l Vol. Sol.
nNH ₄ Br	98	1	2.61	nKBr	119	0.945	2.47
nNH ₄ Cl	53.4	0.96	2.40	nKCl	74.5	0.853	2.22
nNH ₄ NO ₃	80	0.99	2.58	nKNO ₃	101	0.913	2.38
$\frac{1}{2}$ n(NH ₄) ₂ SO ₄	33	0.82	2.14	$\frac{1}{2}$ nK ₂ SO ₄	43.5	0.78	2.04
$\frac{1}{4}$ n(NH ₄) ₂ SO ₄	16.5	0.91	2.37	$\frac{1}{4}$ nK ₂ SO ₄	21.7	0.89	2.32
nNH ₄ C ₂ H ₃ O ₂	77.1	1.09	2.84	nKI	166	0.98	2.56
n(NH ₂) ₂ CO	60.1	1.02	2.66	nNaBr	103	0.035	2.44
$\frac{1}{2}$ nHCl	18.22	0.975	2.54	nNaCl	58.5	0.847	2.21
$\frac{1}{2}$ nH ₂ SO ₄	24.52	0.905	2.36	$\frac{1}{2}$ nNaCl	29.2	0.93	2.42
n C ₆ H ₆ O ₆	150	0.944	2.46	nNaNO ₃	85	0.893	2.32
3nC ₆ H ₆ O ₆	450	0.858	2.24	$\frac{1}{2}$ nNa ₂ SO ₄	35.5	0.73	1.90
Pure C ₃ H ₅ (OH) ₃	1000	0.863	2.26	$\frac{1}{4}$ nNa ₂ SO ₄	17.8	0.855	2.23

Similar data are also given for the solubility of H₂S in aq. C₂H₅OH solutions and in aq. CH₃COOH solutions at 25°.

SOLUBILITY OF HYDROGEN SULFIDE IN ETHYL ALCOHOL (Henrich, 1892; Carius, 1855)

Henrich recalculated Bunsen's data and found an expression which more closely fit the experimental points than did Bunsen's. His equation is $\beta = 18.019 - 0.71259 t + 0.0088556 t^2$, where β is the volume of H₂S (measured at 0°, 760 mm) dissolved in 1 volume of alcohol, and

the temperature is measured in centigrade degrees. The values below were calculated from this equation. Carius used alcohol of density 0.792 (20°).

t°	β		t°	β	
	Henrich	Carius		Henrich	Carius
0	18.02	17.89	15	9.32	9.54
5	14.68	14.78	20	7.31	7.42
10	11.78	11.99	25	5.73	5.62

Freezing point data for the system $\text{H}_2\text{S} + \text{CH}_3\text{OH}$ are given by Baume and Perrot, 1914 and Baume, et al., 1914.

SOLUBILITY OF HYDROGEN SULFIDE IN ANILINE AT 22°
(Bancroft and Belden, 1930)

S

mm. H_2S	Mg. H_2S Dissolved in 1 cc Aniline	mm. H_2S	Mg. H_2S Dissolved in 1 cc Aniline	mm. H_2S	Mg. H_2S Dissolved in 1 cc Aniline
102	2.74	390	10.6	591	16.4
178	4.64	406	11.3	676	18.6
199	5.32	484	13.2	750	20.8
296	8.13	513	14.3	874	24.0
310	8.45	579	15.8	1160	31.6

SOLUBILITY OF HYDROGEN SULFIDE IN SEVERAL SOLVENTS AT 20° AND 760MM.
(Bell, 1931)

The solvents were saturated by bubbling H_2S through them for about 3 hours, using some 8-10 times as much gas as required for saturation. The dissolved gas was determined by displacing it with a current of CO_2 free air and absorbing the H_2S in a known volume of normal NaOH containing an excess of 30% H_2O_2 above that required for oxidation to sulfate. After absorption the excess of H_2O_2 was removed by heating to 60-70° and the excess of alkali was titrated with normal HCl .

S = the partition coefficient of H_2S between the liquid and the vapor; that is $S = C$ (the gm. equiv. per liter) \div 0.0417, since $S/C = 22.4 \times 293/273$.

X = the Mol. Fraction Solubility calculated on the assumption that the densities obey the ideal mixture law.

Solvent	S	X	Solvent	S	X
Hexane	6.30	0.0341	Penta chlor Ethane	10.63	0.0514
Octane	6.80	0.0440	Bromoform	16.76	0.0581
Dodecane	5.71	0.0513	Ethyl bromide	17.80	0.0608
Cetane	5.05	0.0578	Chloroform	32.8	0.103
CycloHexane	7.50	0.0338	Bromo Benzene	12.92	0.0376
Carbon tetrachloride	10.79	0.0419	Chloro Benzene	13.80	0.0388
Benzene	15.68	0.0563	Tetrabrom Ethane(s)	9.49	0.0446
Toluene	16.90	0.0672	Tetra chlor Ethane(s)	16.66	0.0702
Tetra chlor Ethylene	8.90	0.0372	Ethyl bromide	43.3	0.126
Tri chlor Ethylene	13.16	0.0482	Ethylene chloride	23.0	0.0719

H HYDROGEN

Data for the solubility of H_2S in water, benzene, formic acid, acetic acid, acetophenone, and methylene dibromide are given by Cavelli and Falcicola, 1904.

Additional data for monoethanol amine and also for diethanol amine solutions (up to 2.5 N) are given by Leibush and Shneerson, 1950, (15°-50°, varying partial pressures of H_2S). The solubility in monoethanol amine solutions is 2.5 to 3.5 times greater than in diethanol amine solutions. The presence of CO_2 decreases the solubility of H_2S . The results below are in terms of moles of H_2S per mole of monoethanol amine in solution.

s	t°	Partial Pressure mm. H_2S	Gm. Moles Monoethanol Amine per 1000 gms. H_2O						
			0.6	1.0	1.5	2.0	3.0	4.0	5.0
25		700	1.148	1.086	1.050	1.033	1.011	0.998	0.991
		600	1.126	1.072	1.041	1.025	1.004	.991	.984
		500	1.101	1.058	1.032	1.016	0.996	.980	.974
		400	1.080	1.042	1.020	1.006	.985	.971	.963
		300	1.053	1.022	1.002	0.990	.970	.955	.945
		200	1.027	0.998	0.979	.966	.945	.931	.918
		100	0.986	.956	.934	.919	.893	.870	.852
		50	.934	.902	.876	.856	.819	.784	.758
		25	.866	.833	.802	.777	.730	.687	.643
	45	700	1.124	1.051	1.011	0.988	.958	.940	.927
		600	1.097	1.033	0.996	.975	.948	.928	.914
		500	1.070	1.012	.980	.960	.934	.913	.899
		400	1.045	0.993	.961	.943	.918	.897	.880
		300	1.011	.967	.939	.921	.891	.869	.850
		200	0.971	.929	.900	.880	.846	.819	.800
		100	.908	.864	.826	.795	.748	.714	.684
		50	.826	.782	.742	.706	.648	.601	.564
		25	.731	.686	.631	.601	.533	.487	.453
	60	700	1.083	1.040	0.998	.968	.934	.909	.891
		600	1.056	1.011	.970	.944	.910	.884	.865
		500	1.027	0.984	.945	.916	.880	.858	.837
		400	0.995	.952	.912	.885	.848	.821	.801
		300	.960	.916	.876	.847	.810	.778	.753
		200	.908	.863	.822	.793	.751	.714	.683
		100	.811	.757	.708	.674	.624	.581	.547
		50	.694	.634	.576	.532	.474	.425	.386
		25	.551	.490	.433	.388	.331	.291	.285

THE SYSTEM HYDROGEN SULFIDE - PHENOL (Nikitin, Kovalskaya and Pushlenkov, 1951)

[Solid phase $3C_6H_5OH \cdot H_2S$ unless otherwise indicated]

t°	Mole % H_2S	t°	Mole % H_2S	t°	Mole % H_2S	t°	Mole % H_2S
41.0	0.0†	46.1	18.85	45.5	39.5	- 2.4	95.0
39.4	2.20†	47.2	24.28	41.3	52.4	-40.5	97.1
36.0	4.5*	47.4	25.0 m. pt.	36.5	62.0	-61	99.5
37.6	6.05	47.4	28.0	31.4	69.8	-70	99.7
42.0	9.65	47.1	30.0	23.5	79.9	-85	99.9 ^{xx}
44.6	14.45	46.5	35.0	10.8	90.0	-85	100.0††

† Solid phase C_6H_5OH ; *Solid phase $C_6H_5OH + 3C_6H_5OH \cdot H_2S$
^{xx}Solid phase $3C_6H_5OH \cdot H_2S + H_2S$; ††Solid phase H_2S

THE SYSTEM HYDROGEN SULFIDE - PHENYL HYDRAZINE
(Nikitin and Pushlenkov, 1954)

t°	Mole % H ₂ S	t°	Mole % H ₂ S	t°	Mole % H ₂ S	t°	Mole % H ₂ S
Solid Phase C ₆ H ₅ NHNH ₂		Solid Phase 2C ₆ H ₅ NHNH ₂ ·H ₂ S					
19.2	0.0	1.4	33.91	7.6	64.02	-54.5	97.68
17.4	4.80	1.2	34.76	-10.5	73.85	-62.0	98.97
15.0	9.55	1.0	36.27	-16.8	81.29	-70.5	99.56
12.7	14.56	0.8	38.44	-24.0	90.20	-75.5	99.64
9.2	19.46	+0.2	43.48	-28.0	91.72	-85.5	99.75
5.8	26.20	-0.2	47.13	-31.0	92.56	-87.5*	99.78
3.8	29.70	-2.0	54.21	-33.5	94.37	-86.5†	99.88
3.0	31.23	-6.2	63.26	-41.0	96.06	-85.0†	100.0
2.4	32.17						
2.0	32.50	*Solid Phase 2C ₆ H ₅ NH ₂ ·H ₂ S + H ₂ S				† Solid phase H ₂ S	

DISTRIBUTION OF HYDROGEN SULFIDE BETWEEN HYDROCARBONS AND WATER
(Rorschach and Gardner, 1949)

Mixtures of H₂S + N₂ were bubbled through the water-hydrocarbon system and the following distribution ratios were found:

$$K = \frac{\text{gms. H}_2\text{S per gm. of Hydrocarbon}}{\text{gms. H}_2\text{S per gm. of H}_2\text{O}}$$

Hydrocarbon	t°	Gms. H ₂ S per gm. of Hydrocarbon using 100% H ₂ S	Gms. H ₂ S per gm. of Water using 100% H ₂ S	K
Benzene	25	0.01088	0.00165	6.65
Gasoline	15	.0137	.002193	5.65
	25	.0127	.00198	6.30
	35	.00891	.001271	7.0
Kerosene	15	.00662	.001815	3.65
	25	.00623	.00207	3.2
	35	.00526	.001665	3.2

SOLUBILITY OF HYDROGEN SULFIDE IN SOLAR OIL (Petroleum)
(Avdeeva and Pitelina, 1947)

"Solar Oil" is petroleum having M.W. 230; d. 0.8768; initial b.pt. 215°C; VISC. (Engler) 20° - 171, 50° - 128; flash pt. 108°. The data were read from the authors' graphs.

Results at 30°

t°	Gms. H ₂ S per liter of Oil	Volume % H ₂ S in Gas Phase	Gms. H ₂ S per liter of Oil
10	3.90	10	0.3
20	3.38	34	1.0
30	3.01	50	1.5
60	2.38	75	2.2
115	1.50	100	3.0

H HYDROGEN

At pressures between 0 and 15 Atmospheres, the Solubility of H_2S in Gas Oil ($d = 0.8319$ and vapor pressure of 2 mm. at 25°) is expressed by the equation $y = 4.17 (x + 1.7)$.

At pressures between 0 and 9 Atmospheres, the Solubility of H_2S in Heavy Naphtha ($d = 0.8003$ and vapor pressure of 80 mm. at 25°) is expressed by the equation $y = 5.5 (x)$.

In these equations y = Volume of H_2S at 25° and 1 atm. dissolved per 1 vol. of liquid. X = Absolute pressure in atmospheres. (Frolich, Touch, Hogan and Peer, 1931)

At 26° , 5.7 volumes of H_2S dissolve in one volume of ethyl ether (=8.8 gms. per liter, 0.511 N). - Parsons, 1925. Freezing point data for H_2S + ethyl ether are given by Baume and Perrot, 1911, 1914.

35 ml of H_2S (S.T.P.) dissolve in 1 ml. of dimethyl formamide at 25° , 1 atm. partial pressure of H_2S . (Dupont)

SOLUBILITY OF HYDROGEN SULFIDE IN WATER AND IN RUBBER (Venable and Fuwa, 1922)

The gas dissolved by a given amount of air free rubber was pumped out with a Töpler pump and measured over mercury.

100 cc H_2O dissolve 243 cc (at 0° and 760 mm.) H_2S at 21° .
" Rubber " 273 cc (" ") " "

The pressure-composition diagrams of the systems:

H_2S + Propene at -30° , 0° , 15°
 H_2S + Propane at -30° , 0° , 15°
 H_2S + CO_2 at -52° , -26.8° , 0°

are given by Steckel, 1945.

The liquid-vapor equilibrium in the system H_2S - propane at high pressures was determined by Gilliland and Scheeline, 1940.

SOLUBILITY OF HYDROGEN SULFIDE IN LIQUID SULFUR (Fanelli, 1949)

The total pressure was one atmosphere. See also Pelabon, 1897.

t°	Gms. H_2S per 100 gms. S.	t°	Gms. H_2S per 100 gms. S.	t°	Gms. H_2S per 100 gms. S.
126	0.057	273	0.179	313	0.186
141	.067	300	.190	388	.182
150	.088	322	.189	398	.173
158	.117	338	.187	402	.171
167	.133	350	.189	427	.141
175	.139	359	.186	437	.116
202	.160	369	.188	440	.098
233	.177	371	.189	444	.065
				Boiling Point	.049

Pelabon, 1893 determined the solubility of H_2S in liquid selenium.

Freezing-point data have been determined for the following mixtures:

$\text{H}_2\text{S} + \text{CCl}_4$ (Biltz & Brautigam, 1927) $\text{H}_2\text{S} + \text{NH}_3$ (Sheflan & McCrosky, 1932)
 " + CS_2 " " " " + $\text{p-ClC}_6\text{H}_4\text{OH}$ (Nikitin & Joffe, 1952)
 " + SO_2 " " " " " " " "

HYDROGEN O_2 and TrisULFIDES H_2S_2 and H_2S_4

S

Freezing-point data for mixtures of $\text{H}_2\text{S}_2 + \text{S}$ are given by Butler and Maass, 1930, and for $\text{H}_2\text{S}_3 + \text{S}$ by Walton and Whitford, 1930.

SULFURIC ACID H_2SO_4

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THE SYSTEM SULFUR TRIOXIDE - WATER

The system has been studied extensively by cooling-curve techniques, and the various results are in general agreement. Earlier workers identified the 5,3,2,1,1/2 and 0 hydrates of SO_3 . Hultmann and Biltz (1934) also reported 9 and 7 hydrates. A detailed study using the solubility method was made by Gable, Betz and Mason (1950). Each sample was stirred at constant temperature and analyzed for SO_3 . The data show the presence of 7,5,4,3,1,1/2 and 0 hydrates (but not $\text{SO}_3 \cdot 9\text{H}_2\text{O}$), and are given in the table below. Vuillard (1954) measuring cooling curves, reports that his results confirm the findings of Gable, Betz and Maron. The curve drawn by Vuillard is reproduced below. Very careful determinations of the freezing points of solutions containing 74-100.1% H_2SO_4 were made by Kunzler, and Glaue (1952), and from 99.7 to 100.4% by Gillespie (1950). Their freezing points in this range differ somewhat from those of G.B. & M.

Results of Gable, Betz, and Mason (1950)

$\text{SO}_3, \%$ Temp., °C	$\text{SO}_3, \%$ Temp., °C	$\text{SO}_3, \%$ Temp., °C	$\text{SO}_3, \%$ Temp., °C	$\text{SO}_3, \%$ Temp., °C
Solid Phase Ice	Solid Phase $\text{H}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$	Solid Phase $\text{H}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$	Solid Phase $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	Solid Phase H_2SO_4
1.48 - 0.59	32.29 - 65.29 (m)	55.44 - 47.01 (m)	72.65 - 1.36	84.44 - 6.53
1.97 - 1.06	33.62 - 56.59 (m)	56.09 - 44.18 (m)	73.33 - 4.64	84.45 - 9.96
4.38 - 28.27	34.03 - 56.72 (m)	56.93 - 42.76	73.98 - 9.18	84.50 - 10.15 g
6.87 - 3.84	34.81 - 53.48	58.11 - 40.45	74.81 - 15.32	Solid Phase $\text{H}_2\text{S}_2\text{O}_7$
8.74 - 5.14	35.50 - 50.95	59.04 - 39.72	75.41 - 20.72	
10.86 - 7.01	36.25 - 48.47	59.70 - 39.51	75.57 - 23.17	84.58 - 9.15
13.84 - 10.29	37.71 - 43.65	60.15 - 39.87 s	76.02 - 28.24	84.66 - 8.77
16.72 - 14.48	38.54 - 41.49	Solid Phase $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	76.43 - 33.84	84.81 - 4.48
19.52 - 19.95	38.98 - 39.86		76.55 - 34.86 f	84.87 - 4.12
21.41 - 24.66	40.38 - 36.63	59.12 - 52.15 (m)	Solid Phase H_2SO_4	84.83 - 3.44
22.77 - 28.81	41.48 - 34.20	59.41 - 49.08 (m)		85.53 - 1.20
24.32 - 34.34	43.33 - 30.97	59.89 - 44.15 (m)	76.58 - 34.61	85.33 + 1.37
25.98 - 41.18	44.21 - 29.89	60.68 - 34.57	76.91 - 28.94	85.47 + 3.23
26.63 - 44.98	45.20 - 29.10	61.29 - 28.89	77.36 - 24.48	85.92 - 9.07
27.37 - 49.44	46.01 - 28.62	61.97 - 22.81	77.75 - 19.63	86.07 - 12.16
28.13 - 54.62	47.03 - 28.36	62.52 - 18.21	78.39 - 14.91	86.09 - 9.68
28.80 - 59.23	47.42 - 28.41	62.89 - 15.12	78.74 - 9.95	86.28 - 14.27
29.14 - 61.91	49.01 - 29.37	63.63 - 9.82	79.37 - 5.43	86.81 - 19.41
29.64 - 65.31 (m)	49.60 - 29.86	64.76 - 3.21	79.83 - 1.98	86.85 - 19.23
30.09 - 69.22 (m)	51.25 - 32.66	65.07 - 1.40	80.33 + 0.46	87.46 - 24.50
30.30 - 71.21 (m)	52.62 - 36.60	65.58 + 1.24	80.56 - 2.80	87.46 - 24.31
29.20 - 61.98 a	34.10 - 41.66 (m)	66.45 - 4.41	80.87 - 4.97	88.80 - 33.51
30.65 - 73.10 b (m)	55.06 - 40.14 (m)	66.69 - 4.44	81.51 - 9.17	89.08 - 34.42
Solid Phase $\text{H}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	52.81 - 36.50 c	67.53 - 7.13	81.62 - 10.372	89.60 - 34.66
	55.35 - 47.46 d (m)	68.25 - 8.21	81.65 - 10.32	89.65 - 34.90
29.55 - 61.33	Solid Phase $\text{H}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$	68.49 - 8.40	81.69 - 10.22	89.81 - 34.85
30.85 - 58.67		68.79 - 8.16	81.77 - 9.66	89.86 - 35.15
31.62 - 57.12	53.62 - 36.98	68.83 - 8.57	81.80 - 8.36	90.58 - 34.07
33.06 - 55.74	55.08 - 38.38	68.87 - 8.38	82.04 - 8.36	90.85 - 33.12
34.62 - 53.73 b	56.31 - 41.22	69.31 - 8.28	82.67 - 5.51	91.11 - 30.09
Solid Phase $\text{H}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$	57.15 - 43.50 (m)	69.65 - 8.10	82.86 - 3.36	91.61 - 26.37
	57.87 - 44.29 (m)	70.77 - 5.24	83.00 - 1.87	92.74 - 16.11
31.27 - 31.39 (m)	58.53 - 49.35 (m)	70.90 - 5.27	83.36 + 0.78	93.27 - 10.04
31.49 - 69.91 (m)	56.90 - 42.70 d	71.79 - 2.40	83.53 - 1.97	93.11 - 5.32
31.74 - 68.41 (m)	59.10 - 52.85 e (m)	72.35 - 0.00	84.76 - 6.06	93.33 - 3.31
32.72 - 63.27 (m)				93.69 - 2.24

(m) = metastable

a = $\text{H}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ also present

b = $\text{H}_2\text{SO}_4 \cdot 4\text{H}_2\text{O}$ also present

c = $\text{H}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ also present

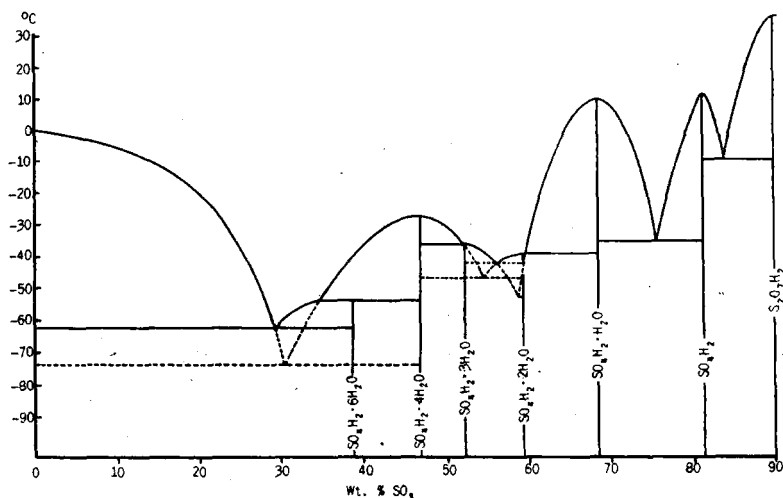
d = $\text{H}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ also present

e = $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ also present

f = H_2SO_4 also present

g = $\text{H}_2\text{S}_2\text{O}_7$ also present

THE PHASE DIAGRAM DRAWN BY VUILLARD (1954):



Freezing point depressions found by Kunzler and Glauque (1952).
 F. P. of 100% H₂SO₄ = 10.371; θ = F.P. lowering. (Selected Data)

Wt. % H ₂ SO ₄	θ	Wt. % H ₂ SO ₄	θ	Wt. % H ₂ SO ₄	θ	Wt. % H ₂ SO ₄	θ
Solid Phase H ₂ SO ₄				Solid Phase H ₂ SO ₄ ·H ₂ O			
100.096	0.288	97.090	18.19	93.382	39.96	87.338	3.80
99.986	0.477	96.622	21.47	92.412	31.07	86.542	1.983
99.816	0.986	96.222	24.32	92.214	29.40	85.794	0.797
99.557	2.57	95.801	27.26	91.583	24.49	85.189	0.233
99.276	4.20	95.311	31.25	90.832	19.35	84.828	0.0562
99.017	5.78	95.062	33.29	90.288	16.07	84.469	0.0002
98.707	7.67	94.513	37.70	89.482	11.79	81.783	3.241
98.378	9.77	94.010	42.20	88.420	7.24	80.154	8.31
97.847	13.16	93.806	44.04	88.748	5.01	78.921	13.63
						77.745	19.77

Older references to the system SO₃-H₂O:

Pfaundler and Schnegg (1875); Pickering (1890, 1890-91); Thilo (1892); Pictet (1894); Knietzsch (1901); Rüdorff (1862); Biron (1899); Marignac (1853); Lespieau (1894); Giran (1913); Berthelot (1874); Kohlrausch (1876); Shertel (1882); Mendelejeff (1899); Raoult (1885); Oddo (1901).

MELTING POINTS IN THE SYSTEM $\text{H}_2\text{SO}_4 + (\text{SO}_3)_2\text{HNO}_3$
(Amelin and Borodastova, 1949)

Wt. % $(\text{SO}_3)_2\text{HNO}_3$	Melting Point	Solid Phase	Wt. % $(\text{SO}_3)_2\text{HNO}_3$	Melting Point	Solid Phase
0.0	10°	H_2SO_4	44.25	28°	$(\text{SO}_3)_2\text{HNO}_3$
9.27	8°	"	53.52	53°	"
18.88	2°	"	62.71	66.5°	"
30.05	- 6.5°	"	71.07	76°	"
40.48	-16.5°	"			

A diagram for the melting points in the system $\text{H}_2\text{SO}_4 + \text{SO}_3 \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ in the region 4-15% N_2O_5 is given by Dode and Pascard (1949). The compound $4\text{SO}_3 \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ melts at about 32°.

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THE SYSTEM $\text{H}_2\text{SO}_4 + \text{H}_2\text{S}_2\text{O}_7 + \text{HSO}_3\text{Cl}$
(Luchinsky, 1940)

The melting points, boiling points, and compositions of the vapor were determined for the entire system. Two compounds are formed: $\text{H}_2\text{S}_2\text{O}_7 \cdot \text{HSO}_3\text{Cl}$ (M.P. 2.6°) and $\text{H}_2\text{S}_2\text{O}_7 \cdot 2\text{HSO}_3\text{Cl}$ (M.P. 3.1°). The invariant points are tabulated below.

t°	Mole % H_2SO_4	Mole % $\text{H}_2\text{S}_2\text{O}_7$	Solid Phase
- 80.0	0.0	0.0	HSO_3Cl
-109.3	13.90	0.0	$\text{HSO}_3\text{Cl} + \text{H}_2\text{SO}_4$
+ 10.4	100.0	0.0	H_2SO_4
- 12	73.1	26.9	$\text{H}_2\text{SO}_4 + \text{H}_2\text{S}_2\text{O}_7$
+ 36	0.0	100.0	$\text{H}_2\text{S}_2\text{O}_7$
- 38.8	0.0	63.36	$\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{S}_2\text{O}_7 \cdot \text{HSO}_3\text{Cl}$
- 15.4	0.0	44.61	$\text{H}_2\text{S}_2\text{O}_7 \cdot \text{HSO}_3\text{Cl} + \text{H}_2\text{S}_2\text{O}_7 \cdot 2\text{HSO}_3\text{Cl}$
-112.6	0.0	16.11	$\text{H}_2\text{S}_2\text{O}_7 \cdot 2\text{HSO}_3\text{Cl} + \text{HSO}_3\text{Cl}$
- 62	41.5	32	$\text{H}_2\text{SO}_4 + \text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{S}_2\text{O}_7 \cdot \text{HSO}_3\text{Cl}$
- 78.4	36	28	$\text{H}_2\text{SO}_4 + \text{H}_2\text{S}_2\text{O}_7 \cdot \text{HSO}_3\text{Cl} + \text{H}_2\text{S}_2\text{O}_7 \cdot 2\text{HSO}_3\text{Cl}$
-116	10	12	$\text{H}_2\text{SO}_4 + \text{HSO}_3\text{Cl} + \text{H}_2\text{S}_2\text{O}_7 \cdot 2\text{HSO}_3\text{Cl}$

MELTING POINTS OF SULFURIC AND SELENIC ACIDS
(Kapustinskii and Zhdanova, 1951)

Only the binary systems indicated were studied.

$\text{H}_2\text{SO}_4 + \text{H}_2\text{SeO}_4$		$\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O} + \text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$		$\text{H}_2\text{SO}_4 \cdot 4\text{H}_2\text{O} + \text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$	
t°	Wt. % H_2SeO_4	t°	Wt. % $\text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$	[continuous solid solutions] t° Wt. % $\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$	
10.3	0.0	9.5	0.0	-28.8	0.0
7.2	8.79	8.5	13.28	-30.7	11.27
5.5	11.05	7.0	26.41	-32.5	24.3
3.2	16 *	5	37.5*	-33.6	31.41
6.3	21.82	5.0	37.65	-37.1	47.02
13.3	31.85	8.0	48.17	-38.8	56.09
21.3	41.92	10.6	56.90	-41.0	65.59
27.3	50.09	12.6	63.41	-43.3	74.35
32.4	58.65	15.6	76.26	-45.7	83.24
38.5	66.27	19.0	85.39	-47.6	88.38
44.5	76.48	21.6	91.01	-50.5	100.0
49.9	87.20	24.0	100.0		
56.0	100.0				

* Eutectic

H HYDROGEN

THE SYSTEM SULFURIC ACID - OXALIC ACID - WATER (Hill, Goulden, and Hatton, 1946)

Results at 25°

	Gms. per 100 gms. sat. sol.		d_{4}^{25}	Solid Phase
	H ₂ C ₂ O ₄	H ₂ SO ₄		
SO	10.2	0.0	1.043	H ₂ C ₂ O ₄ ·2H ₂ O
	6.6	9.6	1.078	"
	4.7	15.4	1.119	"
	3.6	21.5	1.165	"
	2.9	29.5	1.174	"
	2.3	38.6	1.272	"
	2.6	47.1	-	"
	4.6	55.1	1.469	"
	7.8	59.6	1.516	H ₂ C ₂ O ₄ ·2H ₂ O + H ₂ C ₂ O ₄
	5.2	67.4	1.600	H ₂ C ₂ O ₄
	4.0	74.4	1.662	"
	4.1	85.9	1.771	"
	4.6	89.9	1.788	"
	4.6	91.6	-	"

Results at 60°

	Gms. per 100 gms. sat. sol.		d_{17}^{60}	Solid Phase
	H ₂ C ₂ O ₄	H ₂ SO ₄		
	31.6	0.0	1.129	H ₂ C ₂ O ₄ ·2H ₂ O
	25.2	7.2	1.150	"
	20.2	14.2	-	"
	16.6	20.2	-	"
	12.3	33.2	1.294	"
	12.1	38.5	1.334	"
	13.1	43.5	1.387	"
	15.1	44.9	-	"
	20.5	44.6	-	H ₂ C ₂ O ₄ ·2H ₂ O + H ₂ C ₂ O ₄
	19.4	46.4	1.469	H ₂ C ₂ O ₄
	16.5	50.5	1.493	"
	13.9	55.6	1.514	"
	9.5	65.0	1.583	"
	8.6	67.7	1.610	"
	7.2	79.6	1.673	"
	8.3	84.0	-	"
	7.6	71.2	-	"
	8.7	86.5	1.704	"

EQUILIBRIUM IN THE SYSTEM SULFURIC ACID, NITROBENZENE AND WATER AT 17° (Bailey and Hilton, 1936)

Weighed quantities of two of the components were mixed and the third (usually water) added until opalescence appeared. A perfectly sharp end point was usually obtained.

Gm. Mols. per 100 gm. Mols. of the three constituents			Gm. Mols. per 100 gm. Mols. of the three constituents			Gm. Mols. per 100 gm. Mols. of the three constituents		
$C_6H_5NO_2$	H_2O	H_2SO_4	$C_6H_5NO_2$	H_2O	H_2SO_4	$C_6H_5NO_2$	H_2O	H_2SO_4
0.054	84.9	15.0	6.52	44.6	48.9	46.3	17.1	36.6
0.084	80.7	19.2	8.9	42.1	49.0	48.4	16.7	34.9
0.32	66.2	33.5	15.1	36.0	48.9	64.1	10.2	25.7
0.88	57.4	41.7	17.1	34.5	48.4	76.6	5.5	17.9
1.59	53.7	44.7	19.2	32.5	48.3	86.4	3.0	10.6
2.34	51.3	46.4	26.3	27.5	46.2	97.6	0.41	2.02
4.24	48.0	47.8	32.7	23.5	43.8	*98.6	1.4	-
						* 0.03	99.99	-

*These two results by Davis, 1916.

SO

The system $H_2SO_4 - (C_2H_5)_2O - H_2O$ was studied at -10° , 0° , and 20° by Ust-Kachintsev and Khlebnikov, 1939.

Data for the System H_2SO_4 - Phenol - Water are given by Svecova, 1938, and by Vosnessersky and Astachow, 1925.

SOLUBILITY OF SULFURIC ACID IN BENZENE SOLUTIONS OF VALERIC
ACID AT 18°
(Gurwitsch, 1914)

The mixtures were shaken with excess of 95.8% H_2SO_4 at 0° and then brought to equilibrium at 18° .

Gms. Valeric Acid per 100 Gms. Valeric Acid + Benzene	Gms. H_2SO_4 per 100 Gms. of the Sat. Solution
0 = Pure benzene	0
0.584	0.052
1.62	0.104
3.64	0.226
7.60	0.378
17.5	0.454

Data for the distribution of H_2SO_4 between H_2O and benzene solutions of trioctyl amine are given by Allen (1956). Equilibrium constants for the formation of the normal sulfate and for sulfate-bisulfate are evaluated.

Freezing-point data have been determined for the following mixtures:

H_2SO_4 + $ZnSO_4$ and other sulfates	(Kendall and Davidson, 1921)
" + Phenol	(Kendall and Carpenter, 1914; Kendall and Landon, 1920; Kendall and Davidson, 1921)
" + Nitrobenzene	(Masson, 1931)
" + Amyl alcohol	(Archibald, 1932)
" + Tertiary Amyl Alcohol	(" ")
" + <u>n</u> Butyl Alcohol	(" ")

(Contd.)

H HYDROGEN

H_2SO_4 + Acetic acid and a long series of Organic Compounds	(Kendall and Carpenter, 1914; Atsuki and Isshi, 1931)
" + $ClCH_2COOH$	(Pushin and Stanojevic, 1946)
" + $Cl_2CHCOOH$	(" " " ")
" + Cl_3CCOOH	(" " " ")

A number of cryoscopic investigations have been made using H_2SO_4 as solvent:

Solute	Author
phthalic anhydride	Flowers, Gillespie and Wasif (1956)
1,1 diphenyl ethylene	} Gold, Hawes and Tye (1952)
1,1 diphenyl ethanol	
Many ketones and aldehydes	Gillespie and Leisten (1954)
Aromatic ketones	Wiles and Baughan (1953)
(eight) diaryl sulfones	Szmant and Lapinski (1952)
Sulfuryl chloride, 2,4,6 T.N.T., nitromethane, chlorosulfuric acid, methyl sulfate, phosphorous oxychloride, HNO_3 , N_2O_3 , N_2O_4 , N_2O_5 , SO_3 , H_2O , NO_2ClO_4 , NH_4ClO_4 , m-nitroaniline, nitrobenzene, p-nitrotoluene, sodium benzene sulfonate, sodium p-toluene sulfonate, diphenyl sulfone	} Gillespie et al. (1950)
anil sulfites, sulfoxides and sulfones	
picric acid, 2,4,6 T.N.T., 1,3,5 T.N.B., nitromethane (+ SO_3 and H_2O)	} Szmant and Brost (1951)
	Brayford and Wyatt (1955)

30 PYROSULFURIC ACID $H_2S_2O_7$

FREEZING POINTS IN THE SYSTEM PYRO SULFURIC ACID - DIOXANE (Mezhenni, 1948)

Mole % Dioxane	Freezing Point	Solid Phase	Mole % Dioxane	Freezing Point	Solid Phase
0.0	34° a	$H_2S_2O_7$	66.42	78°	1:2
8.08	21° a	"	67.85	79.1°	"
23.75	16.6° a	"	69.01	76°	"
29.50	19.9° a	"	70.02	59.9°	"
40.60	24° a	$H_2S_2O_7$ + 1:2	75.42	49.1°	"
56.2	64.3° a	1:2	84.59	27.0°	"
60.63	69.5° a	"	93.6	7.0°	$C_4H_8O_2$ + 1:2
64.98	74.8°	"	100.0	11.78°	$C_4H_8O_2$

a = Melting points

1:2 = $H_2S_2O_7 \cdot 2C_4H_8O_2$

H HYDROGEN

SOLUBILITY OF SULFAMIC ACID IN ORGANIC SOLVENTS AT 25° (Cupery, 1938)

Solvent	Gms. HSO_3NH_2 per 100 gms. Solvent	Solvent	Gms. HSO_3NH_2 per 100 gms. Solvent
Methanol	4.3	Ether	0.009
Ethanol (2% Benzene)	1.7	Formamide	20.0
Acetone	0.4		

Se HYDROGEN SELENIDE H_2Se

SOLUBILITY IN WATER (de Forcrand and Fonzes-Diacon, 1902)

t°	4°	9.65	13.2	22.5
Vol. H_2Se (at 0° and 760 mm.) dissolved per 1 vol. H_2O }	3.77	3.45	3.31	2.70

SOLUBILITY OF HYDROGEN SELENIDE IN WATER AND IN AQUEOUS SOLUTIONS OF HYDRIODIC ACID AT A PARTIAL PRESSURE OF H_2Se OF 760 MM. (McAmis and Felsing, 1925)

Solubility in Water			Solubility in Aq. HI Solut. at 25°		
t°	Mols. H_2Se per liter sat. sol.	Cc H_2Se (at 0° and 760 mm.) per liter sat. sol.	Mols. HI per liter sat. sol.	Mols. H_2Se per liter sat. sol.	Cc H_2Se (at 0° and 760 mm.) per liter sat. sol.
14.6	0.09789	2194	0.020	0.08478	1900
15.0	0.09611	2154	0.40	0.08634	1935
25.0	0.08415	1886	2.73	0.11012	2468
25.6	0.08277	1855			
35.0	0.07317	1640			

Melting points in the system $\text{H}_2\text{Se} + \text{D}_2\text{Se}$ were determined calorimetrically by Kruis, 1941.

SeO HYDROGEN SELENITE (Selenious Acid) H_2SeO_3

SOLUBILITY IN WATER (Etard, 1894)

t°	Gms. H_2SeO_3 per 100 Gms. Solution	t°	Gms. H_2SeO_3 per 100 gms. Solution	t°	Gms. H_2SeO_3 per 100 Gms. Solution
-10	42.2	25	67.0	60	79.3
0	47.4	30	70.2	70	79.3
+10	55.0	40	77.5	80	79.3
20	62.5	50	79.2	90	79.4

HYDROGEN SELENATE (Selenic Acid) H_2SeO_4

SeO

THE SYSTEM SeO_3 - H_2O

Kremaun and Hofmeier (1908) found the 1-, 2-, and 5-hydrates (H_2SeO_4 , $\text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$, $\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$). In addition, Kapustinskii and Zhdanova (1951) found the incongruently melting trihydrate ($\text{H}_2\text{SeO}_4 \cdot 2\text{H}_2\text{O}$). Vuillard (1956) found an incongruently melting 7-hydrate, but his data are presented only as a diagram. He reports the stable eutectic to be -83.4° ($\text{ICE} + \text{H}_2\text{SeO}_4 \cdot 6\text{H}_2\text{O}$); the transition $\text{H}_2\text{SeO}_4 \cdot 6\text{H}_2\text{O} \longrightarrow \text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$ at -68.5° , 54.8% H_2SeO_4 ; the transition $\text{H}_2\text{SeO}_4 \cdot 2\text{H}_2\text{O} \longrightarrow \text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$ at -24° , 77.7% H_2SeO_4 . Doatal (1955) carefully studied the system in the region SeO_3 - H_2SeO_4 and found the compounds $\text{H}_2\text{Se}_2\text{O}_7$ and $\text{H}_4\text{Se}_3\text{O}_{11}$. $\text{H}_2\text{Se}_2\text{O}_7$ is congruently melting, but its melting point curve is broad and flat, indicating less stability than the corresponding sulfur compound.

Data of Kremann and Hofmeier, 1908

t°	Gms. H_2SeO_4 per 100 Gms. Sat. Sol.	Solid Phase
0	0	Ice
-10	21	"
-20	30	"
-30	36	"
-40	40	"
-50	42.5	"
-60	45	"
-80	48	"
-95 Eutec.	50	" + $\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$
-80	52	$\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$
-70	54	"
-60	58	"
-51 m. pt.	67	"
-55	71.5	"
-65 Eutec.	74	" + $\text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$
-50	75.5	$\text{H}_2\text{S}_2\text{O}_4 \cdot \text{H}_2\text{O}$
-20	79	"
0	81	"
+20	85	"
26 m. pt.	88	"
20	91	"
16 Eutec.	91.5	" + H_2SeO_4
30	93	H_2SeO_4
40	94.5	"
50	96.5	"
60	100	"

(Contd.)

H HYDROGEN

THE SYSTEM SeO_3 - H_2O --Contd.
Data of Kapuatinskii and Zhdanova, 1951

	Gms. H_2SeO_4 per 100 gms.		Solid Phase	t°	Gms. H_2SeO_4 per 100 gms.		Solid Phase
	sat.	sol.			sat.	sol.	
SeO	- 1.5	2.96	ICE	-48.5	74.08		$\text{H}_2\text{SeO}_4 \cdot 2\text{H}_2\text{O}$
	- 2.6	8.09	"	-41.3	74.31		"
	- 4.2	10.86	"	-42.6	75.43		"
	- 9.2	18.80	"	-29.8	76.61		"
	-12.4	25.19	"	-19.5	77.75		"
	-19.2	30.88	"	-20.0	78.75		"
	-25.2	33.11	"	-14.2	79.52		$\text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$
	-35.7	40.17	"	- 8.6	80.05		"
	-45.5	41.75	"	- 6.6	80.45		"
	-54.1	42.44	"	- 0.5	81.03		"
	-70.5	46.71	"	+ 7.4	82.38		"
	-74.1	47.76	"	19.8	84.80		"
	-71.6	54.26	$\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$	24.7	86.85		"
	-63.2	55.60	"	25.4	87.79		"
	-58.0	59.04	"	23.8	88.97		"
	-55.7	59.89	"	21.9	89.96		"
	-54.1	62.15	"	13.9	90.39		H_2SeO_4
	-52.9	64.13	"	28.9	91.96		"
	-51.5	66.23	"	50.8	97.60		"
	-51.9	68.23	"				
	-53.7	69.95	"				
	-55.5	70.39	"				

Data of Dostal (1955)

$\% \text{SeO}_3$	M. pt.*	$\% \text{SeO}_3$	M. pt.*	$\% \text{SeO}_3$	M. pt.*	$\% \text{SeO}_3$	M. pt.*
Solid phase H_2SeO_4		Solid Phase H_2SeO_4 --Contd.		Solid Phase $\text{H}_4\text{Se}_3\text{O}_{11}$ --Contd.		Solid Phase SeO_3	
87.10	60.4	91.37	25.5	92.75	18.8	94.80	15.1
87.30	62.0	91.44	24.3*			94.93	20.5
87.42	62.2	91.59	19.8*	$\text{H}_4\text{Se}_3\text{O}_{11} + \text{H}_2\text{Se}_2\text{O}_7$		95.05	25.9
87.50	62.3	91.80	15.0*	92.8	17.8	95.10	32.7
87.57	62.4†					95.25	34.0
87.69	61.9	$\text{H}_2\text{SeO}_4 + \text{H}_2\text{S}_2\text{O}_7$		Solid Phase		95.37	43.2
87.90	60.9	91.9	12.4*	$\text{H}_2\text{Se}_2\text{O}_7$		95.66	53.0
88.15	59.7					95.85	59.6
88.45	57.8	$\text{H}_2\text{SeO}_4 + \text{H}_4\text{Se}_3\text{O}_{11}$		92.2	14.9*	95.94	65.6
88.78	55.8	91.4	25.4	92.90	18.2	96.51	79.2
89.25	52.5			93.08	18.4	96.72	85.0
89.62	49.3	Solid Phase		93.15	18.7	97.50	97.2
89.80	47.8	$\text{H}_4\text{Se}_3\text{O}_{11}$		93.22	18.7	98.18	105.6
90.22	43.5	91.36	25.4*†	93.37	18.8†	98.71	110.6
90.30	42.1	91.59	25.1	93.68	18.6	98.50	117.3
90.51	39.2	91.65	25.1	93.85	18.4	99.81	118.8
90.55	37.5	91.80	24.7	94.04	17.8	100.0	119.8†
90.63	37.3	92.00	24.4	94.27	16.8		
90.90	33.0	92.17	23.7	94.50	15.5		
90.97	32.5	92.25	23.1	94.68	13.8		
91.02	30.9	92.30	22.6				
91.13	29.5	92.37	22.2	$\text{H}_2\text{Se}_2\text{O}_7 + \text{SeO}_3$		*Metastable	
91.26	27.7	92.45	22.1			† Melting point of compound.	
91.30	26.6	92.65	20.7	94.7	13.5		

FREEZING-POINTS OF MIXTURES OF SELENIC ACID AND SULFUR TRIOXIDE (Meyer and Stateczny, 1922)

A diagram is given and the following numerical data for the principal points of the diagram.

t°	Gms. SO ₃ per 100 gms. mixture	Solid Phase	t°	Gms. SO ₃ per 100 gms. mixture	Solid Phase
+58	0.0	H ₂ SeO ₄	-8.0 Eutec.	40.4	H ₂ SeSO ₇ +H ₂ SeS ₂ O ₁₀
-12 Eutec.	23.0	" +H ₂ SeSO ₇	+19.0 m. pt.	53.0	H ₂ SeS ₂ O ₁₀
+ 6.6 m.pt.	35.0	H ₂ SeSO ₇	-7.0 Eutec.	63.9	" + SO ₃

Si

HYDROGEN SILICIDE H Si

One liter of Cyclohexanol (C₆H₁₁OH) dissolves 97 cc. HSi at 26° and 765 mm. (Cauquill, 1927)

HELIUM He

SOLUBILITY IN WATER

The various data are in reasonable agreement. The numerous determinations of Morrison and Johnstone (1954) are self consistent and lie near the average curve of the earlier data. The results of von Autropoff (1925), Venable and Fuwa (1923), and Estreicher (1899) are too high. The values below are those of Morrison and Johnstone unless otherwise indicated. The older work is reviewed by Lawrence, Loomis, et al. (1946). Additional data are given by Valentiner (1927, 1930).

t°	Ml. He (S.T.P.) per 1000 gms. H ₂ O	t°	Ml. He (S.T.P.) per 1000 gms. H ₂ O	t°	Ml. He (S.T.P.) per 1000 gms. H ₂ O
0	9.32 (3)	24.7	8.47	44.9	8.45
2	9.37 (2)	25.0	8.7 (1)	48.9	8.59
4.6	9.44		8.60 (2)	50.0	8.90 (3)
6.0	9.35		8.64 (3)	55.9	8.81
10.0	8.95 (2)	27.4	8.45	58.6	8.89
11.0	9.04	30.0	8.6 (1)	60.5	9.02
12.0	8.97		8.17 (2)	67.4	9.23
13.2	8.87	33.0	8.34	70.5	9.42
15.0	8.9 (1)	34.6	8.41	71.4	9.42
16.6	8.71	37.0	8.4 (1)	73.0	9.46
20.0	8.8 (1)	40.4	8.41	75.0	9.77 (3)
21.7	8.53				

{ (1) Lannung, 1930; (2) Cady, Elsey and Berger, 1922; (3) Wiebe and Gaddy, 1935
{ (1) (2) (3) Data in ml. He (S.T.P.) per 1000 ml. of water.

He HELIUM

SOLUBILITY OF HELIUM IN WATER AT PRESSURES UP TO 1000 ATMOSPHERES (Wiebe and Gaddy, 1935)

The authors used a simple bubbling-type of apparatus made of a steel cylinder with pressure valves. Equilibrium was approached from both lower and higher pressures. The helium was 99.95% pure. It was found that 1% N impurity had a very decided effect upon raising the solubility, but 0.05% was negligible.

Partial Pressure of He in Atmospheres	cc He (reduced to 0° and 760 mm.) dissolved per 1.0 gm. H ₂ O at:			
	0°	25°	50°	75°
25	0.2322	0.2156	0.2225	0.2442
50	0.4674	0.4332	0.4445	0.4892
100	0.9240	0.8491	0.8827	0.9699
200	1.807	1.688	1.734	1.907
400	3.436	3.241	3.358	3.666
600	4.916	4.681	4.844	5.277
800	6.228	6.015	6.248	6.787
1000	7.421	7.263	7.536	8.251

DATA OF PRAY, SCHWEICKERT AND MINNICH (1952) (In agreement with, and extending those of Wiebe and Gaddy, 1934)

*F	p.s.i. abs.	cc He (S.T.P.) per gm. H ₂ O	*F	p.s.i. abs.	cc He (S.T.P.) per gm. H ₂ O
32	367	0.23 (W. & G.)	500	100	0.40
77	367	.22 (W. & G.)		200	.60
167	367	.24 (W. & G.)		300	.99
325	100	.20		400	1.38
	200	.31		500	1.76
	300	.38	600	200	0.92
				300	1.66
				400	2.49
				500	2.99

SOLUBILITY OF A MIXTURE OF 30 PER CENT HELIUM AND 70 PER CENT NEON IN WATER (Valentiner, 1927)

t°	l (Ostwald Solubility Expression)
0	0.021
17	0.015
45	0.010

The author has collected and recalculated all previous determinations of the solubility of the rare gases in water.

SOLUBILITY OF HELIUM IN AQUEOUS SOLUTIONS OF SALTS AT 25°
(Results of Akerlof, 1935)

Aqueous Solutions of:	Gm. mola. Salt per 1000 gm. H ₂ O	cc He ₂ (at 0° and 760 mm.) in an amt. of solution containing 1.0 gm. H ₂ O
Potassium Chloride	4.72	0.0048
Sodium Chloride	5.81	0.0043
Lithium Chloride	6.18	0.0136
Lithium Iodide	2.40	0.0109
Sodium Nitrate	6.95	0.0039
Perchloric Acid	6.89	0.0187
Water alone	0.0	0.0086

(RESULTS OF MORRISON AND JOHNSTONE, 1955)

Setchenow (salting-out) coefficients at 25°. $k = \frac{\log \frac{S_0}{S}}{c}$ where
 S_0 = solubility in water, S = solubility in the salt solution, c = con-
 centration of salt; all in moles per 1000 gms. H₂O.

Electrolyte	k	Electrolyte	k	Electrolyte	k
NaCl	0.081	NH ₄ Cl	0.027	NaBr	0.087
LiCl	0.050	1/2BaCl ₂	0.086	HNO ₃	-0.013
HCl	0.008	1/2Na ₂ SO ₄	0.118	(CH ₃) ₄ NI	-0.001
KCl	0.068	KI	0.083	(C ₂ H ₅) ₄ NBr	-0.024

SOLUBILITY OF HELIUM IN WATER AND IN WHOLE BLOOD AT 38°
(Hawkins and Shilling, 1936)

The blood of oxen or dogs was oxalated with 0.02 per cent oxalate and used immediately or chilled to nearly 0° and used the next day. The time allowance for saturation was 30 minutes. The O capacity of the blood samples varied from 18 to 21.5 vol. per cent. The H₂O content from 0.77 to 0.89 gm. per cc.

Results for H₂O

Results for Ox and Dog Blood

He pressure in mm. Hg	He content in Vol. Per cent	He Pressure in mm. Hg	He content in Vol. Per Cent
723	0.80	699	0.83
1495	1.68	1466	1.70
3025	3.41	3028	3.54
4620	5.20	4556	5.59

The solubility coefficient for He in Water is 0.085 and that for dog blood was found to vary from 0.083 to 0.089 and that for ox blood to vary from 0.080 to 0.091. The amount of helium dissolved by whole blood under helium pressures varying from 1 to 6 atmospheres (absolute) was found to be directly proportional to the helium pressure in accordance with Henry's law.

He HELIUM

SOLUBILITY OF HELIUM IN NITROMETHANE SOLUTIONS AT 24.85° (Friedman, 1954)

Solvent	Ostwald coefficient
H ₂ O	0.0093 ml. He (at 24.85°, 1 atm.) per ml. solvent
CH ₃ NO ₂	0.0175 " " "
H ₂ O saturated with CH ₃ NO ₂	0.0088 " " "

SOLUBILITY OF HELIUM IN SEVERAL ORGANIC SOLVENTS (Lannung, 1930)

The results are expressed in terms of the Bunsen Absorp. Coef. and the Ostwald Solubility Expression. (See results for the solubility of Helium in Water by Lannung, 1930.)

Results for the Solubility in:

t°	Methyl Alcohol		Ethyl Alcohol		Acetone	
	β	1	β	1	β	1
15	0.0298	0.0314	0.0268	0.0283	0.0284	0.0300
18	0.0307	0.0327	0.0275	0.0293	0.0299	0.0319
20	0.0313	0.0336	0.0281	0.0302	0.0309	0.0332
25	0.0328	0.0358	0.0294	0.0321	0.0331	0.0361
30	0.0343	0.0381	0.0306	0.0340	-	-
37	0.0364	0.0413	0.0325	0.0369	-	-

t°	Benzene		Cyclohexane		Cyclohexanol	
	β	1	β	1	β	1
15	0.0165	0.0174	0.0220	0.0232	-	-
18	0.0174	0.0186	0.0227	0.0242	-	-
20	0.0180	0.0193	0.0236	0.0253	-	-
25	0.0192	0.0210	0.0252	0.0275	0.0100	0.0109
30	0.0202	0.0224	0.0268	0.0297	0.0107	0.0119
37	0.0221	0.0251	0.0293	0.0333	0.0119	0.0135

SOLUBILITY OF HELIUM IN OILS (Burrows and Preece, 1953)

ℓ = Ostwald coefficient (ml. He at t°, 1 atm.) per ml. solvent.

Apeizon GW oil*				Silicone D.C. 702*				Silicone D.C. 200*			
t°	ℓ	t°	ℓ	t°	ℓ	t°	ℓ	t°	ℓ	t°	ℓ
83	0.0360	47.5	.0267	85	0.0311	30	.0183	84	0.0641	45	.0443
82	.0371	34	.0205	84.5	.0308	25	.0174	79.5	.0657	30	.0391
69	.0330	25	.0163	66.5	.0297	21	.0164	66.5	.0596	25	.0361
68.5	.0331	22	.0157	53	.0238	20	.0157	64	.0593	20	.0333
48.5	.0267	20	.0143	46	.0240			47	.0511	20	.0311

*physical constants of the oils: (additional data in original)

d ₂₀ ° 0.878	d ₈₀ ° 0.842	d ₂₀ ° 1.072	d ₈₀ ° 1.023	d ₂₀ ° 0.971	d ₈₀ ° 0.919
Visc 20°, 160.5c.p.;		Visc 20°, 39.8c.p.;		Visc 20°, 104.4c.p.;	
80°, 9.1		80°, 6.4		80°, 35.9	

SOLUBILITY OF HELIUM IN OLIVE OIL

0.015 cc of helium (0°, 760 mm) dissolve in 1 cc of olive oil at 22° and at 37°. (Behnke and Yarbrough, 1938)

Van Slyke, 1939, using an unanalyzed sample of gas, found that helium was only about 1-1/2 times as soluble in olive oil as in water.

SOLUBILITY OF HELIUM IN RUBBER

According to Venable and Fuwa, 1923, 100 cc of H₂O dissolve 1.4 cc. He (reduced to 0° and 760 mm.) at 21°. These authors also found that 100 cc of rubber dissolve about 1.0 cc of helium at 21°, as determined by pumping out the gas with a Töpler pump and measuring it over mercury.

SOLUBILITY OF HELIUM IN LIQUID METHANE
(Fonikberg and Fastovskii, 1940)

90.3° K

106° K

Pressure Kg/cm ²	Mole % He	Pressure Kg/cm ²	Mole % He
30	0.13	26	0.19
78	.27	61	.39
98	.32	100	.63
116	.37	149	.90
139	.46	160	.97
162	.52		

SOLUBILITY OF HELIUM IN LIQUID NITROGEN
(Gonikberg and Fastovskii, 1940a)

The liquid-vapor equilibrium of the system helium-nitrogen at 68°, 77.3°, 90.1°, 107°, and 111.5°K and 200-250 atm. pressure is given by Kharakhorun, 1940. Data on the system from -64° to -90° K at 20-150 atm. is given by Boomer, et. al. (1938).

Results for the region of limited miscibility at 120, 135, 140, 175, 200°C at 100-8600 kg/cm² is reported by Tsiklis, 1952. The System He-CO₂ also exhibits limited gaseous miscibility.

Mole % He			Mole % He			Mole % He		
Pressure			Pressure			Pressure		
Kg/cm ²	Liquid	Vapor	Kg/cm ²	Liquid	Vapor	Kg/cm ²	Liquid	Vapor
78.0° K			90.1° K			109° K		
1.1	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0
18.5	0.5	92.1	20.7	0.6	73.3	27.5	2.3	45.5
44.5	0.9	94.6	35.1	1.1	82.9	44.5	3.5	58.3
68	1.5	96.5	59	2.1	88.7	81	6.2	66.3
105	2.2	96.9	95	3.5	90.2	112	8.2	70.5
147	2.6	97.8	157	4.9	92.3	139	10.6	75.5
208	3.7	98.4	187	5.6	93.1	180	13.1	76.6
269	4.6	98.3	220	6.2	94.1	232	15.9	79.7
295	5.0	-	253	7.0	94.4	249	16.7	81.4
			285	7.9	94.5	286	18.3	82.5

Hf HAFNIUM

SOLUBILITY OF HELIUM IN LIQUID AMMONIA (Ipatjew and Teodorowitsch, 1932)

t°	Pressure in Atm.	cc He ₂ (at 0° and 760mm) dissolved in 1.0 cc NH ₃	t°	Pressure in Atm.	cc He ₂ (at 0° and 760mm) dissolved in 1.0 cc NH ₃
-16	35.5	0.554	+20	23.3	0.465
-10	34.55	0.521	"	38.7	0.719
+20	5.35	0.126	25	37.7	0.750
"	12.6	0.273	30	36.6	0.824

SOLUBILITY OF HELIUM IN MELTS (Gerling, 1940)

Each sample was fused in an atmosphere of helium and held at the temperature indicated for 30 minutes and then cooled, transferred to another vessel and the volume of the liberated helium measured. Each value was corrected for the solubility of helium in the quartz vessels used.

t°	Solvent	Pressure He mm	Solubility (mm ³ He at 0°, 760 mm dissolved in 1 gm. of Melt)
1300	KCl	698	1.13
1300	Gabbrodiabase	513	1.77
900	"	646	1.93(held at 900° for 24 hours)
1300	"	716	2.68

Data for the solubility and rate of diffusion of helium in Pyrex glass (Corning 7740) is given by Rogers, Buritz and Alpert, 1954.

The phase relations and distribution in the He³ - He⁴ system are reported by Weinstock, Osborne and Abraham (1950), and by Davnt and Heer (1952).

HAFNIUM Hf

Br HAFNIUM OXYBROMIDE HfOBr₂

SOLUBILITY IN AQUEOUS SOLUTIONS OF HYDROBROMIC ACID AT 25° (v. Hevesy and Wagner, 1930)

d $\frac{25}{4}$ of sat. sol.	Normality of Aq. HBr	Gms. HfO ₂ per liter sat. sol.	d $\frac{25}{4}$ of sat. sol.	Normality of Aq. HBr	Gms. HfO ₂ per liter sat. sol.
2.0838	0.354	694.5	1.4984	8.77	10.60
1.6989	3.620	314.5	1.7157	13.36	0.80
1.4348	6.568	48.90			

HAFNIUM CUPFERRATE

CH

The solubility in slightly acidic solution is 4×10^{-3} moles per liter. The zirconium compound is at least 18 times more soluble. (Fujiwara, 1951)

HAFNIUM OXYCHLORIDE HfOCl_2

CI

SOLUBILITY OF HAFNIUM OXYCHLORIDE IN AQUEOUS SOLUTIONS OF
HYDROCHLORIC ACID AT 20°
(von Hevesy, 1925)

The hafnium contained 5 per cent ZrO_2 .

Gm. mols.			Gm. mols.		
Normality	d of	HfOCl_2 per	Normality	d of	HfOCl_2 per
aq. HCl	sat. sol.	liter sat. sol.	aq. HCl	sat. sol.	liter sat. sol.
5.64	-	0.167	10.56	1.180	0.0801
6.48	1.127	0.103	11.28	-	0.1509
9.02	1.154	0.053	11.40	-	0.0619
10.33	-	0.0668			

HAFNIUM EXTRACTIONS

Data for the extraction of hafnium from perchloric acid solutions by benzene, n-hexane and $\text{o-C}_6\text{H}_4\text{Cl}_2$ in the presence of 2-thenoyl trifluoroacetone, benzoyl trifluoroacetone and isovaleroyl trifluoroacetone are given by Huffman, Iddings and Osborne, 1955. Data for thenoyl trifluoroacetate in nitric acid solutions is given by McCarty, Dearing and Flagg, 1949. Complexing by NO_3^- and SO_4^{2-} was also studied.

See hafnium oxysulfate for further data.

HAFNIUM Acid oxyFLUORIDE $\text{HfOF}_2 \cdot \text{H}_2\text{F}_2 \cdot 2\text{H}_2\text{O}$

F

SOLUBILITY IN AQUEOUS SOLUTIONS OF HYDROFLUORIC ACID AT 25°
(v. Hevesy and Wagner, 1930)

d $\frac{25}{4}$ of		Gms. HfO_2	d $\frac{25}{4}$ of		Gms. HfO_2
sat. sol.	Normality	per liter	sat. sol.	Normality	per liter
	of Aq. HBr	sat. sol.		of Aq. HBr	sat. sol.
1.577	0.0	413.6	2.050	10.05	903.9
1.537	0.0	475.6	1.899	15.05	733.6
1.650	1.06	568.3	1.902	15.03	741.8
1.655	1.06	571.2	1.394	20.09	250.6
2.036	6.03	892.1	1.404	20.09	258.9
2.040	6.03	897.1			

Hf HAFNIUM

F HAFNIUM POTASSIUM FLUORIDE HfK_2F_6

One liter of aq. 0.125 $\frac{\text{g}}{\text{ml}}$ HF solution dissolves 0.1008 mols. HfK_2F_6 at 20°.
 " 5.89 $\frac{\text{g}}{\text{ml}}$ HF " 0.1942 "
 (von Hevesy, 1925; von Hevesy, Christiansen and Berglund, 1925)

HAFNIUM AMMONIUM FLUORIDES $\text{Hf}(\text{NH}_4)_2\text{F}_6$ and $\text{Hf}(\text{NH}_4)_3\text{F}_7$

SOLUBILITY IN WATER AND AQ. NH_4F SOLUTIONS
 (von Hevesy, 1925; von Hevesy, Christiansen and Berglund, 1925)

Compound	Solvent	t°	Mols. per liter	
			NH_3	Hf
$\text{Hf}(\text{NH}_4)_2\text{F}_6$	Water	0	1.807	0.890
"	"	20	2.832	1.425
$\text{Hf}(\text{NH}_4)_3\text{F}_7$	"	0	1.230	0.425
"	"	20	1.756	0.538
"	0.922 $\frac{\text{g}}{\text{ml}}$ NH_4F	20	-	0.261
"	1.971 " "	20	-	0.108
"	5.01 " "	20	-	0.0258
" + $\text{Hf}(\text{NH}_4)_2\text{F}_6$	Water	20	3.038	1.439

O HAFNIUM OXIDE HfO_2 OH HAFNIUM HYDROXIDE $\text{Hf}(\text{OH})_4$

SOLUBILITY IN WATER
 (Cooley and Banks, 1951)

t°	34.6	49.7	60.0	70.3	89.7
Micrograms					
HfO_2 per 100 gms. H_2O	2.3	2.8	2.9	3.2	4.7

Larsen and Gammill (1950) report the K_{sp} to be 4×10^{-26} , assuming the equilibrium to be $\text{Hf}(\text{OH})_4 \rightleftharpoons \text{Hf}(\text{OH})_2^{++} + 2\text{OH}^-$. Actually, the average metal ion in solution is $(\text{Hf}(\text{OH})_{3.4}^{+0.6})_n$. From dilution experiments yielding precipitation, the K_{sp} seems to be 1×10^{-25} .

FO HAFNIUM OXYPHOSPHATE $\text{HfO}(\text{H}_2\text{PO}_4)_2$

SOLUBILITY OF HAFNIUM PHOSPHATE IN AQUEOUS SOLUTIONS OF
 HYDROCHLORIC ACID AT 20°
 (von Hevesy and Kimura, 1925)

About 0.1 gm. of the compound was shaken 3 days in a thermostat and then allowed to stand many days. 100 cc of the solution filtered through glass wool was evaporated and residue ignited and then weighed.

Normality of aq. HCl	Wt. of ignited residue from 100 cc. sat. sol.	Gm. mols. compd. per liter
5.94	0.0031	0.00009
10.21	0.0043	0.00012
10.48	0.0046	0.00013

HAFNIUM OXYSULFATE HfOSO_4

30

Fischer and Chalybaeus, 1947 report attempts to separate mixtures of hafnium and zirconium compounds by partition between water and ether solutions. Mixed zirconium and hafnium oxysulfates (containing 0.5% HfO_2) were dissolved in a water solution of NH_4SCN and this mixture was then shaken with ether solutions containing 0.4 - 1.6 NH_4SCN . The results using different preparations of the salts, concentrations in the water and ether solutions, volumes, and numbers of extractions are reported.

HYDRARGYRUM Hg

MERCURY Hg

THE SOLUBILITY OF METALLIC MERCURY IN WATER
(Stock, 1934)

By operating with the greatest possible care to remove air from the water and the Hg, the solubility was found to be

0.02 to 0.03% Hg per cc H_2O at 30° ($\gamma = 0.001$ mg.).

When the separation of the water from the Hg was made in the air the solubility rose to 0.06% or more per cc H_2O . This increase is due to oxidation. At 85° the solubility was found to be 0.3% and at 100° 0.6% Hg per cc H_2O .

Experiments were also made at 30° of the solubility of Hg in H_2O in contact with air, both with and without stirring and in presence of oxygen. In the latter case the solubility rose to 39.6% Hg per cc H_2O in 2 months. Using pure red HgO a solubility of 42.4% HgO per cc H_2O was found. Alkali hydroxide in presence of air increased the solubility of Hg to 54% in 5% KOH and to 135% in 10% KOH. Many other experiments of a similar character are described.

Pariaud and Archinard (1952) used thoroughly degassed, neutral water and analyzed the solutions with dithizone. After 10 days, no further increase in solubility was noted. Their value is 25% per liter at 25° , which is in excellent agreement with the data of Stock (above).

SOLUBILITY IN LIQUID PHOSPHORUS
(Rotariu, Schramke, Gilman and Hildebrand, 1951)

At 25° 0.29 mg Hg dissolve in 1 gram of Phosphorus (P_4). ($= 1.76 \times 10^{-4}$ moles/mole or 3.7×10^{-5} cc/cc)

Hg HYDRARGYRUM

Melting point data in the system Hg-Tl indicate a compound Hg_2Tl_5 melting at 15° . (Pushin, 1949a)

Melting points in the system Hg-K are given by Duwell, 1955.

AaO MERCUROUS and MERCURIC ARSENATES

Guerin and Boulitrop report the systems $\text{HgO-As}_2\text{O}_3\text{-H}_2\text{O}$ (1950) and $\text{Hg}_2\text{O-As}_2\text{O}_3\text{-H}_2\text{O}$ (1951) at 60° . 3:1 and 1:1 compounds exist in each system. The 3:1 \rightarrow 1:1 transition occurs in solutions containing 38.1% As_2O_3 and 25% As_2O_3 for the mercuric and mercurous salts respectively.

Br MERCUROUS BROMIDE Hg_2Br_2

SOLUBILITY IN WATER (Sherrill, 1903)

One liter sat. sol. of Hg_2Br_2 in water contains 0.000039 gm. Hg_2Br_2 at 25° .

From the measured E.M.F. of the cell $\text{Hg} \mid \text{Hg}_2\text{Br}_2 \cdot \text{KBr}, \text{C} \mid \text{KNO}_3 \mid \text{C}, \text{KCl} \cdot \text{Hg}_2\text{Cl}_2 \mid \text{Hg}$; $E = 0.1318 - 0.000188t$, the calculated Solubility Product of Hg_2Br_2 is $0.545 \cdot 10^{-23}$ at 25° and $6.95 \cdot 10^{-23}$ at 26.5° .

Br MERCURIC BROMIDE HgBr_2

SOLUBILITY IN WATER (Tourneux and Pernot, 1925; above 100° Benrath, Gjedebo, Schiffers and Wunderlich, 1937)

t°	Gms. HgBr_2 per 100 gms. sat. sol.	t°	Gms. HgBr_2 per 100 gms. sat. sol.	t°	Gms. HgBr_2 per 100 gms. sat. sol.
0	0.3	30	0.65	164	22.4
4.5	0.270 ^a	40	0.9	173	33.5
10	0.4	50	1.25	185	59.1
10.4	0.427 ^a	60	1.65	187	74.7
20	0.55	80	2.7	189	88.1
25	0.61	100	4.7	193	92.8
	0.609 ^a	142	12.0	201	96.2
	0.6135 ^b				

^aTyrell and Richards, 1953

^bMoles and Marquina, 1924

EQUILIBRIUM IN THE SYSTEM MERCURIC BROMIDE - AMMONIA - WATER AT 8°-10°
(Gaudechon, 1910)

The mixtures were shaken intermittently for 21-48 hrs. Both the clear sat. solution and the separated and dried solid phases were analyzed.

Initial Mixture			Sat. Solution			Solid Phase
Gms. Mols. per Liter			Gms. Atoms. per Liter			
HgBr ₂	NH ₃	NH ₄ Br	Hg	Br	N	
0.0125	0.0250	0	trace	0.0154	0.0185	(NHg ₂ Br) ₄ HgBr ₂
0.0166	0.0332	0	0.00032	0.0172	0.0202	36% " + 64% NHg ₂ Br·NH ₄ Br
0.025	0.050	0	0.00078	0.0241	0.0251	NHg ₂ Br·NH ₄ Br
0.050	0.100	0	0.0019	0.0525	0.0514	"
0.0125	0.025	0.0375	0.00178	0.0497	0.0497	"
0.025	0.050	0.075	0.0041	0.103	0.108	"
0.0328	0.0656	0.0984	0.0061	0.133	0.133	93% " + 6% NHgBr·3NH ₄ Br
0.0365	0.073	0.1095	0.0060	0.132	0.133	36% " + 64% NHgBr·3NH ₄ Br
0.050	0.100	0.150	0.007	0.170	0.169	NHg ₂ Br·3NH ₄ Br
0.100	0.200	0.300	0.0124	0.333	0.338	"
0.0180	0.036	0.01875	0.001	0.0315	0.0318	NHg ₂ Br·NH ₄ Br
0.050	0.100	0.006	0.0057	0.1172	0.1178	"
0.050	0.100	0.150	0.0071	0.169	0.168	NHg ₂ Br·3NH ₄ Br
0.100	0.200	0.160	0.0083	0.184	0.187	"
0.125	0.250	0.306	0.0160	0.393	...	"

Data for the system HgBr₂ + KOH + H₂O at 25° are given by Herz (1910).

THE SYSTEM MERCURIC BROMIDE - POTASSIUM BROMIDE - WATER
(Data of Perrot, 1932)

The original results are presented only in the form of a diagram from which the following approximate figures were read.

Results at 0°			Results at 34°			Results at 80°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
KBr	HgBr ₂		KBr	HgBr ₂		KBr	HgBr ₂	
0.0	0.3	HgBr ₂	0.0	0.68	HgBr ₂	0.0	2.7	HgBr ₂
7.5	15.0	"	5.0	15.0	"	10.0	30.0	"
12.0	24.0	" + 1.1.1	10.0	23.0	"	15.0	50.0	"
20.0	31.5	1.1.1	15.0	38.0	"	18.5	75.0	" + 1.1.1
25.0	37.5	"	19.0	51.0	" + 1.1.1	21.5	70.0	1.1.1
30.0	43.2	"	23.0	48.5	1.1.1	25.0	65.0	"
32.5	48.2	" + KBr	28.0	48.0	"	28.0	63.0	"
32.2	40.0	KBr	33.5	55.0	" + KBr	32.0	62.0	" + KBr
31.8	30.0	"	34.0	45.0	KBr	35.0	50.0	KBr
32.5	20.0	"	35.0	30.0	"	40.0	26.0	"
34.0	0.0	"	40.0	15.0	"	44.0	15.0	"
			42.1	0.0	"	48.7	0.0	"

1.1.1 = HgBr₂·KBr·H₂O

Hg HYDRARGYRUM

(DATA OF HERZ AND PAUL, 1913 AT 25°)

Moles KBr per liter	0	0.209	0.770	2.380	3.470
Moles HgBr ₂ per liter	0.017	0.098	0.472	1.360	1.930

(DATA OF SHERRILL, 1903 AT 25°)

Mols. KBr per liter	0	0.05	0.10	0.5	0.866	2	3	4
Mols. HgBr ₂ per liter	0.017	0.055	0.088	0.0359	0.611	1.407	2.096	2.339

THE SYSTEM MERCURIC BROMIDE - SODIUM BROMIDE - WATER AT 15°
(Contet, 1943)

Br The system was studied at 8° and 15° and the results were presented as diagrams only. The shape of the curve at each temperature is about the same. The results below (15°) were read from the diagrams. The results at 8° could not be read with sufficient accuracy to be included. (See also the table below.)

Cms. pm 100 gms. Sat. Sol.

NaBr [±]		HgBr ₂	Solid Phase
10		23	HgBr ₂ .
20		53	"
22		60	HgBr ₂ + 2HgBr ₂ ·NaBr·2H ₂ O
22.5		60	2HgBr ₂ ·HgBr ₂ ·NaBr·2H ₂ O + HgBr ₂ ·NaBr
28		54	HgBr ₂ ·NaBr·2H ₂ O + NaBr
30		52	NaBr + NaBr·2H ₂ O
35		30	NaBr·2H ₂ O

SOLUBILITY OF MERCURIC BROMIDE IN AQUEOUS SALT SOLUTIONS AT 25°
(Herz and Paul, 1913)

66 (The mixtures were constantly agitated for eight days)

In Aq. BaBr ₂		In Aq. CaBr ₂		In Aq. NaBr*		In Aq. SrBr ₂	
Mols. per liter		Mols. per liter		Mols. per liter		Mols. per liter	
BaBr ₂	HgBr ₂	CaBr ₂	HgBr ₂	NaBr	HgBr ₂	SrBr ₂	HgBr ₂
0	0.017	0.072	0.117	0.118	0.078	0.062	0.104
0.274	0.370	0.645	0.676	0.596	0.285	0.328	0.471
0.396	0.540	1.892	1.358	1.142	0.540	0.668	0.902
0.579	0.759	2.479	2.766	2.448	1.276	1.401	1.770
1.096	1.478	3.754	3.666	5.246	2.306	1.872	2.238

*See also above

SOLUBILITY OF HgBr_2 IN ALCOHOL SOLUTIONS

Methanol

Gms. HgBr_2 per 100 gms. methanolAbsolute CH_3OH

t°	Lloyd, Brown, Glynwyn, Bonnel, and Jones (1928)		Timofeiew (1894)	99.88 wt. % CH ₃ OH (d ₄ ²⁰ = 0.7961) (Malhotra, 1928)
0	-		41.15	-
10	53.5	a	49.5	-
19	-		66.3	-
20	65.3	a	-	-
22	70.3	a	60.9	67.62 (22.1°)
27	71.6	b	-	68.81 (27.4°)
30	72.1	b	-	70.25 (30.8°)
36.1	-		-	73.31
39	-		71.3	-
40	76.0	b	-	-
50	81.9	b	-	84.43 (49.8°)
60	85.1	b	-	-
65	-		90.8	-
97	-		139.1	-

^aSolid phase $\text{HgBr}_2 \cdot \text{CH}_3\text{OH}$ ^bSolid phase HgBr_2 In Aq. Methyl Alcohol
(Herz and Anders, 1907)

Wt. % CH_3OH in Solvent	d_{20}^{20} of Sat. Sol.	Gms. HgBr_2 per 100 cc Sat. Sol.
10.6	0.9857	0.72
30.77	0.9588	1.29
47.06	0.9401	2.52
64	0.9386	6.85
78.05	0.9744	14.66
100	1.2275	50.25

Ethanol

In Absolute Ethanol
(Lloyd, Brown, Glynwyn, Bonnel
and Jones, 1928)

(Timofeiew, 1894)

t°	Gms. HgBr_2 per 100 gms. $\text{C}_2\text{H}_5\text{OH}$	Solid Phase	t°	Gms. HgBr_2 per 100 Gms. $\text{C}_2\text{H}_5\text{OH}$
0	27.3	HgBr_2	0	25.2
10	28.2	"	10	26.3
20	28.6	"	19	29.7
25	30.0*	"	39	31.9
30	31.6	"	65	44.5
40	34.0	"	89	66.9
50	36.2	"		
60	42.3	"		
70	46.3	"		

*Herz and Anders, 1907.

(Contd.)

Hg HYDRARGYRUM

SOLUBILITY OF HgBr₂ IN ALCOHOL SOLUTIONS--Contd.

Ethanol--
Contd.

In Aqueous Ethanol
(Data of Malhoira, 1928)

Results for Ethyl Alcohol of 87.73 Wt. % C ₂ H ₅ OH		Results for Ethyl Alcohol of d ₄ ²⁰ = 0.7943 = 99.78 Wt. % C ₂ H ₅ OH			
t°	Gms. HgBr ₂ per 100 gms. solvent	t°	Gms. HgBr ₂ per 100 gms. C ₂ H ₅ OH	t°	Gms. HgBr ₂ per 100 gms. C ₂ H ₅ OH
32.9	17.22	0.0	24.04	44.80	34.55
42.13	21.44	16.15	26.25	48.60	35.87
45.20	22.91	24.95	28.40	53.20	37.80
49.07	25.35	29.15	29.28	58.00	39.80
55.85	28.61	31.35	30.05	60.15	40.63
61.60	31.84	34.30	31.29	64.80	43.10
68.97	37.11	41.60	33.53	79.25	60.15

(Data of Reinders, 1900)

(Data of Herz and Anders, 1907)

In 95% C ₂ H ₅ OH (d ₁₅ = 0.8126)		Wt. % C ₂ H ₅ OH in Solvent		Gms. HgBr ₂ per 100 cc Sat. Sol.	
t°	Gms. per 100 gms. Sat. Sol.		d ₂₅ of Sat. Sol.		
0	13.2	0	1.0022	0.60	
25	16.53	20.18	0.9717	0.67	
50	22.63	40.69	0.9435	1.59	
		70.01	0.9214	6.58	
		100	0.9873	22.81	

Propanol
isoButanol

Propanol
(Timofeiew, 1894)

iso-Butanol
(Timofeiew, 1894)

t°	Gms. HgBr ₂ per 100 Gms. C ₃ H ₇ OH	t°	Gms. HgBr ₂ per 100 Gms. C ₃ H ₉ OH
0	14.6	0	4.61
10	15.6	10	5.63
19	15.5	23	6.65
39	20.8	39	9.58
65	31.3	65	15.80
86.5	42.7		

Glycerol

Aqueous Glycerol at 25°
(Moles and Marquina, 1924)

Solvent	d ₂₅ of sat. sol.	Gms. HgBr ₂ per 100 gms. solvent
Water	1.0023	0.6135
Aq. 25.0% glycerol	1.0651	0.9840
" 75.2 "	1.2204	3.456
" 99.2 "	1.4000	15.687

(Contd.)

SOLUBILITY OF MERCURIC BROMIDE IN MIXTURES OF ALCOHOLS AT 25°
(Herz and Kuhn, 1908)

Mixtures	In Mixtures of Methyl and Ethyl Alcohols			In Mixtures of Methyl and Propyl Alcohols		
	% CH ₃ OH in Mixture	$\frac{d_{25}}{4}$ of Sat. Sol.	Gms. HgBr ₂ per 100 cc. Sat. Sol.	2 C ₂ H ₅ OH in Mixture	$\frac{d_{25}}{4}$ of Sat. Sol.	Gms. HgBr ₂ per 100 cc Sat. Sol.
0		0.9873	22.8	0	1.227	50.20
4.37		0.9932	23.1	11.11	1.1954	47.28
10.4		1.009	25.4	23.8	1.1524	41.53
41.02		1.080	33.3	65.2	1.0257	25.30
80.69		1.185	45.7	91.8	0.9437	16.35
84.77		1.193	46.8	93.75	0.0368	15.80
91.25		1.211	48.6	96.6	0.9275	14.66
100		1.227	50.2	100	0.9213	13.78

Br

In Mixtures of Ethyl and Propyl Alcohols

% C ₂ H ₅ OH in Mixture	$\frac{d_{25}}{4}$ of Sat. Sol.	Gms. HgBr ₂ per 100 cc Sat. Sol.
0	0.9873	22.80
8.1	0.9802	22.25
17.85	0.9740	21.06
56.6	0.9487	17.63
88.6	0.9269	14.76
91.2	0.9239	14.64
95.2	0.9227	14.06
100	0.9213	13.78

THE SYSTEM MERCURIC BROMIDE - MERCURIC CHLORIDE - ETHANOL AT 25°
(van Pelt, Jr., and de Boer, 1934)

The solid phase consists of a series of mixed crystals up to about 70 per cent HgBr₂.

Gms. per 100 gms. sat. sol.		Per cent HgBr ₂ in Solid Phase	Gms. per 100 gms. sat. sol.		Per cent HgBr ₂ in Solid Phase
HgCl ₂	HgBr ₂		HgCl ₂	HgBr ₂	
31.35	0.0	--	17.4	20.5	50
31.0	3.3	--	14.0	22.4	60
27.3	7.1	14	10.7	22.8	--
25.8	9.8	27	10.4	22.1	--
26.0	10.0	--	6.7	24.6	100
24.0	12.2	--	3.8	20.2	100
22.2	14.1	41	0.0	18.1	--

Hg HYDRARGYRUM

THE SYSTEM MERCURIC BROMIDE - POTASSIUM BROMIDE - ETHANOL AT 34° (Perriot, 1933)

The original results are given only in the form of diagrams from which the following approximate figures have been read.

Results for Absolute C ₂ H ₅ OH			Results for 95 Per cent C ₂ H ₅ OH		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HgBr ₂	KBr		HgBr ₂	KBr	
25.0	0.0	HgBr ₂	19.0	0.0	HgBr ₂
35.0	3.0	"	30.0	3.0	"
40.0	4.5	"	40.0	6.0	"
45.0	6.0	" + 1.1.A	45.5	7.2	" + 1.1.H
40.0	6.0	1.1.A	35.0	7.2	1.1.H
25.0	6.0	"	30.0	7.5	"
20.	6.0	"	25.5	8.5	"
20	7.0	" + KBr	28.0	12.0	"
15	5.5	KBr	30.5	14.5	" + KBr
10	4.0	"	20.5	10.0	KBr
5	2.0	"	10.0	5.0	"

1.1.A = HgBr₂·KBr·C₂H₅OH

1.1.H = HgBr₂·KBr·H₂O

SOLUBILITY OF MERCURIC BROMIDE IN VARIOUS ORGANIC SOLVENTS

Solvent	t°	Solubility		Author
Methyl acetate	18°	100 gms. methyl acetate dissolve 21.93 gms. HgBr ₂ at 18° (d ₁₈ sat. sol. = 1.090).		(Naumann, 1909)
Ethyl acetate	18°	100 gms. ethyl acetate dissolve 13.05 gms. HgBr ₂ at 18°.		(Naumann, 1910)
	25°	Wt. % CH ₃ CO ₂ C ₂ H ₅ in Solvent	d ₂₅ of Gms. HgBr ₂ per 100 cc Sat. Sol. Sat. Sol.	
		0	1.0022	0.60
		4.39	1.0018	0.574
		96.76	1.1159	26.69
		100	1.0113	14.13
				(Herz and Anders, 1907)
Acetone	25°	33.9 gms. HgBr ₂ per 100 gms. sat. sol.		(Zapata and Zapata, 1930)
		34.76 gms. HgBr ₂ per 100 gms. sat. sol.		(Reinders, 1900)

SOLUBILITY OF MERCURIC BROMIDE IN VARIOUS ORGANIC SOLVENTS--Contd.

Solvent	t°	Solubility		Author
Carbon disulfide	t°	Gms. HgBr ₂ per 100 Gms. Solution	Gms. HgBr ₂ per 100 Gms. Solution	
		t°		
	-10	0.049	15	0.140
	- 5	0.068	20	0.187
	0	0.087	25	0.232
	+ 5	0.105	30	0.274
	110	0.122		(Arctowski, 1894)
Chloroform	18-20	0.126 gms. HgBr ₂	per 100 gms. solvent	(Sulc, 1900)
Bromoform	18-20	0.679	" "	(" ")
Carbon tetrachloride	18-20	0.003	" "	(" ")
Ethyl bromide	18-20	2.31	" "	(" ")
Ethylene dibromide	18-20	2.34	" "	(" ")
Acetic acid (anhydrous)	t°	Mols. HgBr ₂ per 100 mols. HgBr ₂ + CH ₃ COOH		Solid Phase
	16.5	0.194	CH ₃ COOH	
	25	0.261	HgBr ₂	
	32	0.287	"	
	41	0.350	"	
	51	0.413	"	
	58	0.477	"	
	71	0.650	"	
	75	0.707	"	
	86	0.860	"	
	92	0.998	"	
	97	1.13	"	
	103	1.29	"	
	110	1.50	"	(Davidson and Chappell, 1938)
Pyridine	t°	Gms. HgBr ₂ per 100 Gms. C ₅ H ₅ N		Solid Phase
		Mol. % HgBr ₂		
	10	5	24	HgBr ₂ ·2C ₅ H ₅ N
	30	8	39.64	"
	50	11.2	57.49	"
	80	17.5	96.68	"
	100	22	128.5	"
	110	24.5	147.8	"
	118†	33.3	227.6	"
	110	35.5	250.8	"
	107*	39	291.5	HgBr ₂ ·2C ₅ H ₅ N+HgBr ₂ ·C ₅ H ₅ N
	110	40.4	309	HgBr ₂ ·C ₅ H ₅ N
	120	45.5	381.3	"
	123†	50	455.8	"

(Staronka, 1910)

*Eutec. †m. pt.

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC BROMIDE IN VARIOUS ORGANIC SOLVENTS--Contd.

Solvent	t°	Solubility		Author
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Pyridine--Contd.

t°	Mol. % HgBr ₂	Gms. HgBr ₂ per 100 Gms.		Solid Phase	
		C ₅ H ₅ N			
125	51	474.4		3HgBr ₂ ·2C ₅ H ₅ N	
130	54.2	539.4		"	
134†	60	683.7		"	
133	64	810.4		"	(Staronka, 1910)
† m. pt.					

Br

Aniline

t°	Gms.		Solid Phase
	Mol. % HgBr ₂	HgBr ₂ per 100 Gms. C ₆ H ₅ NH ₂	
60	4	16.14	HgBr ₂ · 2C ₆ H ₅ NH ₂
70	5.8	23.83	"
80	8.3	35.04	"
90	12.2	53.80	"
100	18.8	89.64	"
105	23.2	116.9	"
110†	33.3	193.3	"
109.7*	33.5	195	" + HgBr ₂ · C ₆ H ₅ NH ₂
115	37.2	229.3	HgBr ₂ · C ₆ H ₅ NH ₂
120	42.3	283.8	"
124	50	387.2	"
123	55.4	480.9	" (Staronka, 1910)

* Eutec. † m. pt.

Quinoline

t°	Mol. % HgBr ₂	Gms. HgBr ₂ per 100 Gms.		Solid Phase
		C ₉ H ₇ N		
88	4.4	12.85		HgBr ₂ ·2C ₉ H ₇ N
111	8.9	27.28		"
127	14.3	46.58		"
134	17.6	61.16		" (Staronka, 1910)

Nitrobenzene
o,m,p-Nitrotoluene
α Nitro naphthalene

} (Mascarelli, 1906; Mascarelli and Ascoli, 1907)

Benzene 25° One liter benzene dissolves 6.99 gms. HgBr₂ (Abegg and Sherrill, 1903)

SOLUBILITY OF MERCURIC BROMIDE IN VARIOUS ORGANIC SOLVENTS---Contd.

Benzene + H₂O DISTRIBUTION OF MERCURIC BROMIDE BETWEEN WATER AND
BENZENE (THIOPHENE FREE) AT 25°
(Sherrill, 1903)

Mols. per Liter		Dist. Coef.	Mols. per Liter		Dist. Coef.
H ₂ O Layer	C ₆ H ₆ Layer		H ₂ O Layer	C ₆ H ₆ Layer	
0.017	0.0194	0.876	0.00634	0.00715	0.89
0.01147	0.01303	0.88	0.00394	0.00436	0.90
0.00953	0.01074	0.89	0.00320	0.00353	0.90

Data are also given for the distribution between aqueous potassium iodide solutions and thiophene free benzene at 25°.

Br

Benzene +
Ethanol SOLUBILITY OF MERCURIC BROMIDE IN AN EQUIMOLECULAR
MIXTURE OF ETHYL ALCOHOL AND BENZENE
(Dukelski, 1907)

t°	0.	10.	20.	30.	40.	50.	60.
Gms. HgBr ₂ per 100							
Gms. Sat. Sol.	10.7	12	14	16	17.5	19	21

Ethyl ether 18° 8.1 gms. HgBr₂ per 100 gms. solvent.
34° 45.6 " " "

Data for the solubility of mixed crystals of HgBr₂ + HgI₂ in acetone at 25° and in ethyl alcohol of $d_{15} = 0.8126 = 95\%$ at 0°, 25°, and 50° are given by Reinders (1900). In the case of acetone, the ratio of HgBr₂ in the solution increases with increase of per cent of HgBr₂ in the solid phase. In the case of the alcohol solutions the ratio in solution does not show such regular variations with change of per cent of HgBr₂ in the solid phase.

SOLUBILITY OF HgBr₂ IN LIQUID SO₂

100 gms. of liquid Sulfur Dioxide dissolve 0.074 gm. HgBr₂ at 0°.
(Jander and Ruppolt, 1937)

Melting-point data have been determined for the following systems:

HgBr ₂ + HgCl ₂	(Losana, 1926)
" + HgI ₂	"
" + " + HgCl ₂	"
" + HgSO ₄	(Paic, 1930, 1933)
" + AgNO ₃	(Bergman, 1922-24, 1926; Bergman, Genke and Isaikin, 1922-24)
" + TlNO ₃	(" " ")
" + TlSO ₄	(Woskresenskaja, 1929)
" + PbBr ₂	(Sandonnini, 1912, 1924)
" + NaBr ₂	(Belyaev and Mironov, 1952a)
" + KBr	(" " ")
" + NH ₄ Br	(" " ")
" + Iodine + Naphthalene	(Smirnov, 1954)
" + Se	(Olivari, 1912)

Hg HYDRARGYRUM

Data for the solubility of many salts, double salts and organic compounds in molten HgBr_2 is given by Jander and Brodersen, 1950.

Br METHYL MERCURIC BROMIDE CH_3HgBr

The solubility in water at 25° is 6.5×10^{-3} moles per liter. (Waught, Walton and Laawick, 1955) The value of Okamoto and Nagayama, 1952 is 2.7×10^{-6} moles per liter. (?)

BrO MERCURIC BROMATE $\text{Hg}(\text{BrO}_3)_2$ Basic MERCURIC BROMATE $\text{Hg}(\text{OH})\text{BrO}_3$

SOLUBILITY OF EACH IN AQUEOUS SOLUTIONS OF PERCHLORIC ACID AND OF NITRIC ACID AT 25°
(Smith, 1924)

Results for $\text{Hg}(\text{BrO}_3)_2$ in Aq:

Perchloric Acid		Nitric Acid	
Approx. Normality of HClO_4	Gms. $\text{Hg}(\text{BrO}_3)_2$ per 100 cc sat. sol.	Approx. Normality of HNO_3	Gms. $\text{Hg}(\text{BrO}_3)_2$ per 100 cc sat. sol.
2.0	6558	2.0	14.66
2.5	5.22	3.0	15.00
3.0	4.13	4.0	14.99
3.5	3.40	5.0	14.75
4.0	2.58		
5.0	1.55		

Results for HgOHBrO_3 in Aq:

Perchloric Acid		Nitric Acid	
Approx. Normality of HClO_4	Gms. HgOHBrO_3 per 100 cc sat. sol.	Approx. Normality of HNO_3	Gms. HgOHBrO_3 per 100 cc sat. sol.
0.0 (= H_2O)	0.081	1.0	12.52
1.0	4.34	2.0	21.30
2.0	5.94		
2.5	6.06		
3.0	6.06		

C MERCUROS ACETYLIDE Hg_2C_2

The "hydrolytic solubility product" $L = [\text{Hg}_2^{++}][\text{C}_2\text{H}_2][\text{OH}^-]^2$ was 1×10^{-50} in 1.0 M HCl and 2×10^{-48} in 0.1 M HCl .

MERCUROUS ACETATE $\text{Hg}_2(\text{CH}_3\text{COO})_2$

CH

SOLUBILITY IN SEVERAL SOLVENTS

Solvent	t°	Solubility	Author
Water	21	0.1024 g. $\text{Hg}_2(\text{CH}_3\text{COO})_2$ per 100 cc sat. sol.	(Legerlotz, 1918)
	25	The Ksp is 2.0×10^{-15} .	(Bargarsky 1897, reported by Brodsky, 1929)

Aq. acetic acid 21 Recrystallized mercurous acetate was rubbed with water or aqueous acetic acid until thoroughly wet and the mixture constantly shaken in a thermostat for 120 hours. The saturated solution was analyzed by adding a slight excess of NaCl to precipitate HgCl and this latter filtered, dried and weighed.

Solvent	Gms. $\text{Hg}_2(\text{CH}_3\text{COO})_2$ per 100 cc sat. sol.	
Water	0.1024	
Aq. acetic acid (conc.=2)	0.0730	
" (conc.=4)	0.0690	
" (conc.=6)	0.0650	(Legerlotz, 1918)

[The amount of acetic acid corresponding to conc. 2, 4 and 6 is not stated.]

Methanol	15	1.24 gms. $\text{Hg}_2(\text{CH}_3\text{COO})_2$ per 100 gms. solvent	} (Henstock, 1934)
	66.3(b.pt.)	1.40 gms. $\text{Hg}_2(\text{CH}_3\text{COO})_2$ per 100 gms. solvent	

Hydrazine 20 (anhydrous)	2.0 gms. $\text{Hg}_2(\text{CH}_3\text{COO})_2$ per 100 cc solvent with precipitation of Hg.	(Welsh and Broderson, 1915)
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MERCURIC ACETATE $\text{Hg}(\text{CH}_3\text{COO})_2$

CH

SOLUBILITY IN WATER
(Long and Kobe, 1951)

Mercuric acetate hydrolyzes in water and precipitates HgO. With the possible exception of temperatures below zero degrees, it is necessary to have acetic acid present if pure acetate is the saturating phase. The authors calculated the hydrolysis constants up to 100°. The data below are the compositions of solutions saturated with $\text{Hg}(\text{CH}_3\text{COO})_2 + \text{HgO}$ at each temperature. If more acetic acid is present, $\text{Hg}(\text{CH}_3\text{COO})_2$ is the saturating phase; less acetic acid leaves only HgO.

Hg HYDRARGYRUM

t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.		t°	Gms. per 100 gms. sat. sol.	
	Hg(CH ₃ COO) ₂	CH ₃ COOH		Hg(CH ₃ COO) ₂	CH ₃ COOH		Hg(CH ₃ COO) ₂	CH ₃ COOH
- 1.5	20.7*	-	30	31.97	1.08	65	58.35	2.04
0	20.72	0.36	35	34.89	1.21	70	62.58	2.12
5	22.41	0.26	40	37.90	1.37	75	67.44	2.00
10	24.09	0.32	45	41.14	1.53	80	72.43	2.00
15	25.58	0.61	50	44.90	1.64	85	77.40	1.79
20	27.72	0.73	55	48.76	1.76	90	80.40	1.77
25	29.63	0.91	60	53.18	1.89	100	86.32	1.50

*Eutectic

CH

SOLUBILITY OF MERCURIC ACETATE IN SEVERAL SOLVENTS

Solvent	t°	Solubility			Author
Methanol	15	7.54 gms. Hg(CH ₃ COO) ₂ per 100 gms. solvent			(Henstock, 1934)
	66.7(b.pt.)	49.84	"	"	(")
Acetone	15	0.60	"	"	(")
Ethylene glycol	Room	0.186	"	"	(Isbin and Kobe, 1945)
Ethylene diamine	Room	17.8	"	"	(")
Monoethanol amine	Room	The salt decomposes			(")
Liquid SO ₂	0	0.095 gms. per 100 gms. solvent			(Jander and Ruppolt, 1937)
(Data of Mameli and Cocconi, 1922)					
Acetic Acid + Phenol Mixtures	15	Gms. per 100 gms. sat. sol.			
		Hg(CH ₃ COO) ₂	C ₆ H ₅ OH	CH ₃ COOH	
		34.03	51.93	14.04	
		40.08	51.90	8.02	
		7.40	8.40	84.20	
		42.02	52.20	5.78	
		9.65	19.46	70.89	
		35.46	52.82	11.72	
		8.61	18.65	72.74	
		9.23	34.99	55.78	
		13.56	43.76	42.68	
		28.53	50.76	20.71	

Freezing point data for Hg(CH₃COO)₂ + C₆H₅OH and other combinations are also given.

MERCUROUS TRIFLUOROACETATE $\text{Hg}_2(\text{CF}_3\text{COO})_2$ **SOLUBILITY IN WATER AND BENZENE**
(Swarts, 1939)

Solvent	t°	Gms. $\text{Hg}_2(\text{CF}_3\text{COO})_2$ per 100 gms. sat. sol.
H_2O	20	20
C_6H_6	20	4.1
	Boiling pt.	12

The compound $\text{Hg}_2(\text{CF}_3\text{COO})_2 \cdot 2\text{H}_2\text{O}$ melts at 72°.

MERCURIC TRIFLUOROACETATE $\text{Hg}(\text{CF}_3\text{COO})_3$

49.72 gms. $\text{Hg}(\text{CF}_3\text{COO})_3$ dissolve in 100 gms. CF_3COOH at 29.8°. The solid phase is unsolvated. (Hara and Cady, 1954)

PHENYL MERCURIC ACETATE $\text{C}_6\text{H}_5\text{HgOOCCH}_3$

CH

The solubility in water at 25° is 1.3×10^{-3} moles per liter.
(Okamoto and Nagayama, 1952)

MERCURY FULMINATE $\text{HgC}_2\text{H}_2\text{O}_2$

One liter of solution in water contains 0.70 gm. $\text{HgC}_2\text{N}_2\text{O}_2$ at 12° and 1.76 gms. at 49°. (Holleman, 1896.)

MERCUROUS TARTRATE $\text{Hg}_2\text{C}_4\text{H}_4\text{O}_6$

The Solubility Product of Mercurous Tartrate in Water at 18°, as quoted from Behrend, 1894, by Brodsky, 1929, is 2×10^{-10}

MERCURIC BENZOATE $\text{Hg}(\text{C}_6\text{H}_5\text{COO})_2 \cdot \text{H}_2\text{O}$ **SOLUBILITY IN SEVERAL SOLVENTS**

Solvent	t°	Solubility	Author
Water	15	1.2 gms. $\text{Hg}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 gms. H_2O	(Tarugi and Checchi, 1901)
	20	0.209 gms. $\text{Hg}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 cc sat. sol.	(Ephraim and Pfister, 1925)
	100	2.5 gms. $\text{Hg}(\text{C}_6\text{H}_5\text{COO})_2$ per 100 gms. H_2O	(Tarugi and Checchi, 1901)

Hg HYDRARGYRUM

SOLUBILITY IN SEVERAL SOLVENTS--Contd.

Solvent	t°	Solubility				Author
Methanol	15	3.67	gms. Hg(C ₆ H ₅ COO) ₂	per		(Henstock, 1934)
		100	gms. solvent			
	66.5(b.pt.)	3.67	"	"	"	(")
Acetone	15	7.23	"	"	"	(")
Benzene	15	2.49	"	"	"	(")

CN MERCURIC CINNAMATE (C₆H₅CH·CHCOO)₂Hg·H₂O

SOLUBILITY IN WATER

t°	Gms. salt per 100 gms. H ₂ O	Author
25	0.03	(De Jong, 1906)
100	0.53	(Tarugi and Checchi, 1901)

MERCURY (ic) OIPHENYL Hg(C₆H₅)₂

The solubility in water at 25° is 2.8×10^{-5} moles per liter (Okamoto and Nagayama, 1952).

Fusion-point data for mixtures of Hg(C₆H₅)₂ + Sn(C₆H₅)₄ and for Hg(C₆H₅)₂ + Sb(C₆H₅)₃ are given by Cambi, 1912.

MERCURIC DIAZOAMINO BENZENE Hg(C₆H₅N=N-C₆H₅)₂

SOLUBILITY IN ALCOHOLS (Watt and Fernelius, 1935)

Alcohol	t°	Gms. Hg(C ₆ H ₅ N=N-C ₆ H ₅) ₂ per liter sat. sol.
Methyl Alcohol	25	0.0116
Ethyl Alcohol	25	0.0052
n Propyl Alcohol	25	0.0228

CN MERCURIC CAMPHOR CARBONATE Hg(C₁₀H₁₆O·CO₂)₂

SOLUBILITY IN SEVERAL SOLVENTS (Picon, 1931)

This compound is made by allowing camphoric acid and yellow oxide of mercury to react in the cold in presence of a small amount of water.

Solvent	t°	Gms. Hg(C ₁₀ H ₁₅ O·CO ₂) ₂ per liter sat. sol.
Methyl Alcohol	15	44.9
Ethyl Alcohol	10	46.0
Ethyl Ether	10	133.0
Acetone	12.5	84.7
Ethyl Acetate	12.5	82.6
Chloroform	12.5	376.2
Carbon Tetrachloride	12.5	215.9
Benzene	15.0	560.3
Carbon Disulfide	15	341.25
Petroleum Ether	10	43.4
Gasoline	10	145.2
Oil	15	50.0

MERCURY NITROSOPHENYL HYDROXYLAMINE Hg[C₆H₅·N(NO) O]₂ [Cupferrate]

CH

This compound is prepared by precipitating in acid solutions, salts of mercury with "Cupferron" (the ammonium salt of nitroso phenyl hydroxylamine). Its solubility in water at 18° is less than 1.3×10^{-6} gm. atoms or 0.3 mg per liter. (Pinkus and Martin, 1927)

MERCURIC PALMITATE Hg(C₁₆H₃₁COO)₂

MERCURIC STEARATE Hg(C₁₇H₃₅COO)₂

SOLUBILITY OF EACH SEPARATELY IN SEVERAL SOLVENTS AT 20°
(Dietzel and Sedlmeyer, 1928)

Weighed amounts of compound and solvent were shaken for 30 hours. The mixture was then filtered and the excess of undissolved compound weighed and the amount dissolved found by difference.

Results for Hg Palmitate Hg(C ₁₆ H ₃₁ O ₂) ₂		Results for Hg Stearate Hg(C ₁₈ H ₃₅ O ₂) ₂	
Solvent	Gm. Mols. Hg(C ₁₆ H ₃₁ O ₂) ₂ per liter sat. sol.	Solvent	Gm. Mols. Hg(C ₁₈ H ₃₅ O ₂) ₂ per liter sat. sol.
Abs. Ethyl Alcohol	0.0005404	Abs. Ethyl Alcohol	0.0006809
Ethyl Ether	0.0005460	Ethyl Ether	0.0005061
Chloroform	0.0007627	Chloroform	0.0007279
Mixture of Alcohol, Chloroform & Pyridine	0.01261	Mixture of Alcohol, Chloroform & Pyridine	0.001380

MERCUROUS CYANIDE Hg₂(CN)₂

CN

One liter of a saturated solution in water at 25° contains 8.1×10^{-14} gms. Hg₂(CN)₂. (Kryukova, 1939).

Hg HYDRARGYRUM

CN MERCURIC CYANIDE $\text{Hg}(\text{CN})_2$

SOLUBILITY IN WATER

t°	Gms. $\text{Hg}(\text{CN})_2$ per 100		Authority
	Gms. Sat. Sol.	cc Sat. Sol.	
- 0.45 Eutec.	about 10 (?)	...	(Guthrie, 1878)
0	6.31	...	(Brinkley, 1922)
5	7.51	...	(Noonan, 1941)
13.5	8.5	...	(Timofeiew, 1894)
15	11.1	...	(Marsh and Struthers, 1905)
20	...	9.3	(Konowalow, 1898, 1899)
25	10.00	11.12	(Sherrill, 1903)
25	10.12	10.95 ($d_{25} = 1.0813$)	(Herz and Anders, 1907; See also Brodsky, 1929) (Griffiths)
101.1	35.05	...	(Benrath, Gjedebø, Schiffers and Wunderlich, 1937)
108	35.8	...	
125	42.9	...	
140	49.8	...	
156	56.7	...	
175	63.4	...	
209	72.8	...	

SOLUBILITY IN WATER AND DEUTERIUM OXIDE AT 5.0° (Noonan, 1948)

The solubility of $\text{Hg}(\text{CN})_2$ was determined in ordinary water and in water containing 91.43% deuterium oxide. These data were then extrapolated to obtain the solubility in pure deuterium oxide.

	H_2O (Ordinary water)	91.43% D_2O	100% D_2O
Moles $\text{Hg}(\text{CN})_2$ per 100 moles solvent	0.537	0.434	0.424

SOLUBILITY OF MERCURIC CYANIDE IN AQUEOUS SOLUTIONS OF AMMONIA AT 0° (Brinkley, 1922)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
$\text{Hg}(\text{CN})_2$	NH_3		$\text{Hg}(\text{CN})_2$	NH_3	
6.31	0.0	$\text{Hg}(\text{CN})_2$	24.68	9.40	$\text{Hg}(\text{CN})_2 \cdot \text{NH}_3$
8.46	0.43	"	25.41	9.55	" $+\text{Hg}(\text{CN})_2 \cdot 2\text{NH}_3$
11.66	1.09	" $+\text{Hg}(\text{CN})_2 \cdot \text{NH}_3$	24.04	11.23	$\text{Hg}(\text{CN})_2 \cdot 2\text{NH}_3$
9.40	2.06	$\text{Hg}(\text{CN})_2 \cdot \text{NH}_3$	23.40	12.59	"
10.32	4.08	"	24.46	16.87	"
15.43	6.82	"	43.57	22.09	"
17.51	7.67	"	66.10	21.51	"
19.31	8.25	"	79.30	20.70	"

One liter 5.2% aqueous NH_3 solution dissolves 204.3 gms. $\text{Hg}(\text{CN})_2$ at about 20°. (Konowalow, 1898)

THE SYSTEM MERCURIC CYANIDE - POTASSIUM CYANIDE - WATER AT 25°
(Corbet, 1926; Sherrill, 1903 (*))

Due to the difficulty of preparing KCN free from KOH the saturated solutions were prepared from double salts which were free of KOH. The solutions were kept in contact with an atmosphere of coal gas previously washed by being passed through solutions of lead acetate and NaOH.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. aat. sol.		Solid Phase
KCN	Hg(CN) ₂		KCN	Hg(CN) ₂	
41.7	0.00	KCN	12.81	39.96	K ₂ Hg(CN) ₄
39.7	0.49	KCN + K ₂ Hg(CN) ₄	11.37	41.85	Hg(CN) ₂
29.47	2.34	K ₂ Hg(CN) ₄	3.97	20.34	"
17.34	11.09	"	* 1.09	13.53	"
14.54	15.54	"	* 0.56	11.83	"
12.54	20.65	"	* 0.28	10.89	"
* 12.51	31.19	"	* 0.00	10.00	"

Data for the distribution of Hg(CN)₂ between aqueous KCN and ether at 25° are given by Sherrill, 1903.

SOLUBILITIES OF MERCURIC CYANIDE DOUBLE SALTS IN WATER AND
IN ALCOHOL

Double Salt	t°	Gms. per 100 Grams		Observer
		Water	Alcohol	
Hg(CN) ₂ ·2KCN	cold	22.7	...	(Frommuller)
Hg(CN) ₂ ·2TlCN	1°	12.6	...	
Hg(CN) ₂ ·2TlCN	10°	9.7	...	
2Hg(CN) ₂ ·CaBr ₂ ·5H ₂ O	cold	100.0	50.0	(Custer)
2Hg(CN) ₂ ·CaBr ₂ ·5H ₂ O	boiling	400.0	100.0	"
Hg(CN) ₂ ·KCl·H ₂ O	18°	14.81	...	(Brett)
Hg(CN) ₂ ·KBr·2H ₂ O	18°	7.49	...	"
Hg(CN) ₂ ·KBr·2H ₂ O	boiling	100.0+	...	"
Hg(CN) ₂ ·BaI ₂ ·4H ₂ O	cold	6.42	4.42	(Custer)
Hg(CN) ₂ ·BaI ₂ ·4H ₂ O	boiling	250.0	62.5 (90% Alc.)	"
Hg(CN) ₂ ·KI	cold	6.2	1.04 (34°B Alc.)	(Caillot)
Hg(CN) ₂ ·NaI·2H ₂ O	18°	22.2	15.4 (90% Alc.)	(Custer)
Hg(CN) ₂ ·SrI ₂ ·6H ₂ O	18°	14.3	25.0 (90% Alc.)	"

SOLUBILITY OF MERCURIC CYANIDE IN AQUEOUS SOLUTIONS OF
POTASSIUM SODIUM TARTRATE AND OF SODIUM ACETATE AT 18-20°
(Bordelanu, 1933)

In aqueous solutions of:

KNaC ₄ H ₄ O ₆ ·4H ₂ O		CH ₃ COONa	
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
KNaC ₄ H ₄ O ₆	Hg(CN) ₂	NaCH ₃ COO	Hg(CN) ₂
7.5	9.65	8.84	9.11
10.0	9.69	16.57	9.40
15.0	10.38	32.52	9.69
20.0	10.73		

SOLUBILITY OF MERCURIC CYANIDE IN VARIOUS ORGANIC SOLVENTS

Solvent	t°	Solubility			
Methanol	0-67	In Absolute Methanol (Dukelski, 1907)		In Aqueous Methanol at 25° (Herz and Anders, 1907)	
		t°	Gms. Hg(CN) ₂ per 100 Gms. Sat. Sol.	Wt. % CH ₃ OH in Solvent	$\frac{d_{25}}{4}$ of Sat. Sol.
		0	26.10	10.6	1.0640
		14.17	29.17	30.77	1.0484
		15	25.68*	47.06	1.0426
		23.4	32.01	64	1.0441
		25	31.80	78.05	1.0484
		27.4	31.77	100	1.0762
		31.7	32.53		
		38.1	33.29		
		44.5	34.05	*Henstock, 1934 Herz and Anders, 1907	
		67	37.50*		

Ethanol	0-40	In Absolute Ethanol (Timofeiew, '94; de Bruyn, '92; Herz and Kuhn, 1908)		In Aqueous Ethanol at 25° (Herz and Anders, 1907)	
		t°	Gms. Hg(CN) ₂ per 100 Gms. Sat. Sol.	Wt. % C ₂ H ₅ OH in Solvent	$\frac{d_{25}}{4}$ of Sat. Sol.
		0	8.3	0	1.0813
		10	8.8	20.18	1.0339
		20	9.25	40.69	1.0006
		25	9.53*	70.01	0.9419
			9.58†	100	0.8552
		30	9.8	* $\frac{d_{25}}{4}$ = 0.8552 † Herz and Anders, 1907.	
		40	10.3		

SOLUBILITY OF MERCURIC CYANIDE IN VARIOUS ORGANIC SOLVENTS--Contd.

Solvents	t°	Solubility		
Propanol	13.5	100 gms. propyl alcohol dissolve	3.79 gms. $\text{Hg}(\text{CN})_2$	(Timofeiew, 1894)
	25	100 cc of sat. sol'n. (of density $d_{25} = 0.8283$) contain	3.44 gms. $\text{Hg}(\text{CN})_2$.	(Herz and Kuhn, 1908)
Methanol + Ethanol	25	% CH_3OH in Mixture	d_{25} of Sat. Sol.	Gms. $\text{Hg}(\text{CN})_2$ per 100 cc Sat. Sol.
		4.37	0.8618	9.02
		10.4	0.8707	10.10
		41.02	0.9267	16.70
		80.69	1.024	28.20
		84.77	1.034	29.60
		91.25	1.052	30.00
		100	1.076	34.30 (Herz and Kuhn, 1908)
Methanol + Propanol	25	% $\text{C}_3\text{H}_7\text{OH}$ in Mixed Solvent	d_{25} of Sat. Sol.	Gms. $\text{Hg}(\text{CN})_2$ per 100 cc Sat. Sol.
		0	0.7878	1.0760
		11.11	0.7894	1.0327
		23.80	0.7907	0.9891
		65.20	0.7954	0.8800
		91.80	0.7992	0.8376
		93.75	0.7995	0.8335
		96.60	0.7999	0.8322
		100	0.8004	0.8283
				3.44 (Herz and Kuhn, 1908)
Ethanol + Propanol	25			
		0	0.7867	0.8552
		8.1	0.7886	0.8549
		17.85	0.7902	0.8527
		56.6	0.7926	0.8386
		88.6	0.7973	0.8311
		91.2	0.7979	0.8306
		95.2	0.7986	0.8293
		100	0.8004	0.8283
				3.44 (Herz and Kuhn, 1908)
Methanol + Benzene		100 gms. of a sat. sol. in a mixture of equimolar amounts of $\text{CH}_3\text{OH} + \text{C}_6\text{H}_6$ contain:		
	10		10.2 gms. $\text{Hg}(\text{CN})_2$	
	30		13 "	
	50		15 "	(Dukelski, 1907)
Ethyl acetate	25	Wt. % $\text{CH}_3\text{COOC}_2\text{H}_5$ in Solvent	d_{25} of Sat. Sol.	Gms. $\text{Hg}(\text{CN})_2$ per 100 cc. Sat. Sol.
		0	1.0810	10.95
		4.39	1.0798	10.83
		96.76	1.9374	2.66
		100	0.9097	1.80 (Herz and Anders, 1907)

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC CYANIDE IN VARIOUS ORGANIC SOLVENTS--Contd.

Solvents	t°	Solubility									
Acetone	15°	100 gms. acetone dissolve 10.3 gms. Hg(CN) ₂ . (Henstock, 1934)									
Acetonitrile	18	9.58 gms. Hg(CN) ₂ per 100 gms. solvent. (Naumann and Schier, 1914)									
Benzonitrile	18	1.093 gms. Hg(CN) ₂ per 100 gms. solvent. (Naumann, 1914)									
Aniline	40-90	t° of solidification 41° 49 58.5 65 77 83.5 84 88.5 Mol. % Hg(CN) ₂ in sat. Solution 3.7 5.7 7.7 9 14.2 18.2 19.7 23.4 [The solid phases are the unstable Hg(CN) ₂ ·C ₆ H ₅ NH ₂ and the stable Hg(CN) ₂ ·2C ₆ H ₅ NH ₂ (m.pt. about 90°).] (Staronka, 1910)									
CN											
Bromoform	18-20	0.005 gms. Hg(CN) ₂ per 100 gms. solvent. (Sulc, 1900)									
Carbon tetrachloride	18-20	0.001	"	"	"	"	"	"	"	"	
Ethyl bromide	18-20	0.013	"	"	"	"	"	"	"	"	
Ethylene dibromide	18-20	0.001	"	"	"	"	"	"	"	"	
Pyridine	9-141	(Staronka, 1910)									
		Mols. Hg(CN) ₂ per 100 Mols. Hg(CN) ₂ + C ₅ H ₅ N									
	t°	Solid Phase									
	9	7.1	Hg(CN) ₂ ·6C ₅ H ₅ N								
	11	8.7	"								
	12.2	10.4	"								
	13	11.3	"								
	13.5	12.9	"								
	14.5	13.8	"								
	16.5	15.8	"								
	20.5*	15.9	"								
	22.5	17.3	"								
	28.5	18.4	"								
	32	19.3	"								
	38	20.6	"								
	42	22.3	"								
	46	23.7	"								
	53	25.3	2Hg(CN) ₂ ·3C ₅ H ₅ N								
	54.5	26°	"								
	56.5	26.6	"								
	68	27.5	Hg(CN) ₂ ·C ₅ H ₅ N								
	70	27.7	"								
	86	29	"								
	111	32	"								
	122.5	33.8	"								
	125	34.4	"								
	141	38.3	"								
*100 gms. pyridine dissolve 64.8 gms. Hg(CN) ₂ at 18°. (Schroeder, 1905)											

SOLUBILITY OF MERCURIC CYANIDE IN VARIOUS ORGANIC SOLVENTS---Contd.

Solvents	t°	Solubility
Quinoline	45-192	(Staronka, 1910)
	t°	Mols. Hg(CN) ₂ per 100 Mols. Hg(CN) ₂ + C ₉ H ₇ N
	45	4.2
	54	6
	89 (61°)	8.2
	99 (61°)	9.2
	137	13.2
	161	17.4
	180	22.5
	192	27.1
		Solid Phase
		Hg(CN) ₂ ·3C ₉ H ₇ N
		" tr. pt. 60°
		Hg(CN) ₂ ·2C ₉ H ₇ N(?)
		"
		"
		"
Ethyl ether	25	One liter of saturated solution contains 2.53 gms. Hg(CN) ₂ (Abegg and Sherrill, 1903)
Glycerol	15.5 27	gms. Hg(CN) ₂ per 100 gms. glycerol. (See Semenchenko and Shakparonov, 1948)
Phenol		Data for the ternary system, mercuric cyanide, phenol, water are given by Timmermans, 1907.
Liquid SO ₂	0°	0.014 gms. Hg(CN) ₂ per 100 gms. liquid SO ₂ . (Jander and Ruppolt, 1937)

Basic MERCURIC CYANIDE HgO·Hg(CN)₂

CN

SOLUBILITY OF MERCURY OXY CYANIDE IN AQUEOUS SOLUTIONS AT 18-20°
(Bordelanu, 1933)

In aqueous solutions of:

KNaC ₄ H ₄ O ₆ ·4H ₂ O		NaCH ₃ COO		H ₃ BO ₃	
Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.		Gms. per 100 gms. sat. sol.	
KNaC ₄ H ₄ O ₆	HgO·Hg(CN) ₂	NaCH ₃ COO	HgO·Hg(CN) ₂	H ₃ BO ₃	HgO·Hg(CN) ₂
0.0	1.315	8.25	1.291	0.4	1.80
12.0	3.18	18.74	1.170	1.4	1.94
20.0	4.39	35.72	1.063	2.4	2.00
42.0	5.73			3.4	2.18

The author also gives results showing that the presence of Hg(CN)₂ has little effect upon the above solubilities.

Hg HYDRARGYRUM

SCN MERCUROUS THIOCYANATE $\text{Hg}_2(\text{SCH})_2$

The Solubility Product of Mercurous Thiocyanate in Water at 25° is 3.0×10^{-20} as quoted by Brodsky, 1929 from Immerwahr, and 1.4×10^{-20} as quoted from Grossmann, 1905.

One liter of saturated solution in water at 25° contains 2.7×10^{-7} gms. $\text{Hg}_2(\text{CNS})_2$. (Kryukova, 1939).

MERCURIC THIOCYANATE $\text{Hg}(\text{SCN})_2$

SOLUBILITY IN WATER AT 25°

100 gms. of saturated solution contain 0.063 gms. $\text{Hg}(\text{SCN})_2$ (Mason and Forgeng, 1931)

THE SYSTEM MERCURIC THIOCYANATE - POTASSIUM THIOCYANATE - WATER AT 25° (Mason and Forgeng, 1931)

The authors determined the following triple points of the system:

Gms. per 100 gms. sat. sol.		Solid Phase
KSCN	$\text{Hg}(\text{SCN})_2$	
0.0	0.063	$\text{Hg}(\text{SCN})_2$
2.05	4.05	" + $\text{KHg}(\text{SCN})_3$
33.1	49.1	$\text{K}_2\text{Hg}(\text{SCN})_4$ + "
66.4	10.4	" + KSCN
70.5	0.0	KSCN

The extraction of $\text{Hg}(\text{SCN})_2$ by ether from aqueous solutions containing NH_4SCN has been studied by Bock, 1951.

100 gms. liquid Sulfur Dioxide dissolve 0.02 gm. $\text{Hg}(\text{SCN})_2$ at 0° . (Jander and Ruppolt, 1937)

SCN MERCURIC ZINC THIOCYANATE $\text{HgZn}(\text{SCN})_4$

SOLUBILITY OF MERCURIC ZINC THIOCYANATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE (Cuveller, 1935)

Measured amounts of aqueous solutions of $\text{HgNa}_2(\text{SCN})_4$, $\text{Zn}(\text{NO}_3)_2$, $\text{Cu}(\text{SCN})_2$ and NH_4Cl of known concentration were mixed and the amount of zinc not precipitated as $\text{HgZn}(\text{CNS})_2$ was determined by a colorimetric comparison.

Thus the amount of $\text{HgZn}(\text{SCN})_4$ remaining in solution at each concentration of NH_4Cl was estimated by difference.

(Contd.)

SOLUBILITY OF MERCURIC ZINC THIOCYANATE IN AQUEOUS
SOLUTIONS OF AMMONIUM CHLORIDE--Contd.

Normality of Aq. NH_4Cl	Gms. $\text{HgZn}(\text{SCN})_4$ per 100 gms. sat. sol.	Normality of Aq. NH_4Cl	Gms. $\text{HgZn}(\text{SCN})_4$ per 100 gms. sat. sol.
0.022	0.0766	0.714	0.462
0.044	0.110	1.000	0.505
0.089	0.173	1.428	0.534
0.178	0.255	1.843	0.546
0.357	0.353		

MERCUROUS CARBONATE Hg_2CO_3

CO

One liter of saturated solution in water at 25° contains 8.8×10^{-9} gms. Hg_2CO_3 . (Kryukova, 1939)

The Solubility Product of mercurous carbonate in water at 25° is 9.0×10^{-17} as quoted from Immerwahr by Brodsky, 1929.

MERCUROUS OXALATE $\text{Hg}_2\text{C}_2\text{O}_4$

CO

The Solubility Product of mercurous oxalate in water at 25° is 2×10^{-13} as quoted from Behrend by Brodsky, 1929.

MERCURIC OXALATE HgC_2O_4

100 gms. H_2O dissolve 0.0107 gm. HgC_2O_4 at 20° . (Trifnov, 1924, 1925)

Data for the system, $\text{HgC}_2\text{O}_4 + \text{K}_2\text{C}_2\text{O}_4 + \text{H}_2\text{O}$ at 20° are also given. The five branches of the curve have, respectively, for solid phase: HgC_2O_4 ; $\text{K}_2\text{C}_2\text{O}_4 \cdot \text{HgC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, $2\text{K}_2\text{C}_2\text{O}_4 \cdot \text{HgC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$, $3\text{K}_2\text{C}_2\text{O}_4 \cdot \text{HgC}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$ and $\text{K}_2\text{C}_2\text{O}_4$.

MERCUROUS CHLORIDE Hg_2Cl_2

CI

SOLUBILITY IN WATER

Dry and Gledhill (1955) found a saturated solution of Hg_2Cl_2 in water at 25° to contain a total of 7.5×10^{-6} moles per liter of mercury. The salt hydrolyzes and oxidizes in solution and the various species are as follows (moles per liter): H^+ : 8.17×10^{-8} ($\text{pH} = 5.085$), Cl^- : 8.40×10^{-6} , $\text{Hg}(\text{OH})_2$: 4.03×10^{-6} , HgCl_2 : 3.3×10^{-8} , HgOH^+ : 10×10^{-8} , HgCl^+ : 2.7×10^{-8} , Hg_2^{++} : 1.90×10^{-8} , HgOH^+ : 1.4×10^{-8} , Hg^{++} : 1.46×10^{-10} .

Hg HYDRARGYRUM

t°	Gms. Hg ₂ Cl ₂ per 100 gms. sat. sol.	Ksp	Ref.
0.5	0.000140	-	(1)
10.8	0.000179	2.22 x 10 ⁻¹⁹	(2)
11	0.000175	2.0 x 10 ⁻¹⁹	(3)
14.9	0.000205	3.31 x 10 ⁻¹⁹	(2)
15	0.000207	3.4 x 10 ⁻¹⁹	(3)
18	0.00021	-	(1)
	0.000075 (?)	-	(4)
19	0.000238	5.3 x 10 ⁻¹⁹	(3)
19.2	0.000243	5.42 x 10 ⁻¹⁹	(2)
20	0.000038	-	(5)
24.6	0.00027	-	(1)
25	0.00177*	-	(*)
25	0.000047 (?)	-	(6)
26.5	0.000307	12.2 x 10 ⁻¹⁹	(3)
	0.000342	15.1 x 10 ⁻¹⁹	(2)
43	0.00070	-	(1)

(1) Kohlrausch, 1908; (2) Brodsky, 1929; (3) Brodsky and Scherschewer, 1926; (4) Behrend, 1893; (5) Ley and Heimbucher, 1904; (6) Sherrill, 1903; (*) Calculated from the total Hg in solution (Dry and Gledhill, 1955).

SOLUBILITY OF MERCUROUS CHLORIDE IN AQUEOUS CHLORIDE SOLUTIONS AT 25° (Richards and Archibald, 1902)

Solid phase in each case: Calomel + about 0.1 gm. of mercury.

In Aqueous NaCl			In Aqueous BaCl ₂		
Sp. Gr. of Solutions	Gms. per Liter		Sp. Gr. of Solutions	Gms. per liter	
	NaCl	HgCl		BaCl ₂	HgCl
...	5.85	0.0041	1.088	104.15	0.044
1.040	58.50	0.041	1.134	156.22	0.088
1.078	119	0.129	1.174	208.30	0.107
1.093	148.25	0.194	1.263	312.54	0.231
1.142	222.3	0.380			
1.188	292.5	0.643			

In Aqueous CaCl ₂			In Aqueous HCl		
Sp. Gr. of Solutions	Gms. per liter		Sp. Gr. of Solutions	Gms. per liter	
	CaCl ₂	HgCl		HCl	HgCl
...	39.96	0.022	...	31.69	0.034
...	35.5	0.033	...	36.46	0.048
1.064	111	0.081	1.042	95.43	0.207
1.105	138.75	0.118	1.069	158.4	0.399
1.151	195.36	0.231	1.091	209.2	0.548
1.205	257.52	0.322	1.114	267.3	0.654
1.243	324.67	0.430	1.119	278.7	0.675
1.315	432.9	0.518	1.132	317.3	0.670
1.358	499.5	0.510	1.153	364.4	0.673

Ferry and Riley, 1946 calculated the solubility of HgCl in Sea water to be 0.0000003 gms. per cc. at 25° (pH = 8.1).

Data for the system Mercurous Chloride + KOH + H₂O at 25° are given by Herz, 1911.

SOLUBILITY OF Hg₂Cl₂ IN BROMOFORM

100 gms. bromoform, CHBr₃, dissolve 0.055 gm. Hg₂Cl₂ at 18°-20°. (Sulc, 1900)

MERCURIC CHLORIDE HgCl₂

Cl

SOLUBILITY IN WATER

The various data are in generally good agreement. The equilibrium curve is S shaped, with an inflection at about 100°. Over most of the curve the maximum deviation of the data from the average is ± 0.1%. Below 20°, the values of Eddy and Menzies (1940) are somewhat higher than the others, as are those of Benrath, Gjedebø, Schiffers and Wunderlich (1937) between 100° and 150°.

Unless otherwise indicated, the data below are the average curve from the results of Etard, 1894; Foote, 1903; Osaka 1903-08; Herz and Paul 1913; Greenish and Smith, 1903; Schreinemakers and Thonus, 1912; Sherrill, 1903; Morse 1902; Laird, 1920; Moles and Marquina, 1914, 1924; Tourneux, 1919; Toda, 1921; Ditte, 1881; Meerberg, 1908; Foote and Levy, 1906; Herz and Anders, 1907; Abé, 1912; Tichomirow, 1907; Flottmann, 1928; Benrath, 1927; Benrath and Ammer, 1929; Sugden, 1929; Bassett, Barton, Foster and Pateman, 1933; Thomas, 1939; Benrath, Gjedebø, Schiffers and Wunderlich, 1937 and Eddy and Menzies, 1940.

Gms. HgCl ₂ per		Gms. HgCl ₂ per		Gms. HgCl ₂ per	
t°	100 gms. sat. sol.	t°	100 gms. sat. sol.	t°	100 gms. sat. sol.
0	3.5 (4.5) ¹	80	23.4 ² , d	141	70.6 ³
5	4.1 (4.8) ¹	90	29.6	145	73.2 ³
10	4.6 (5.2) ¹	100	36.5 ^{1,2,e}	150	78.5
15	5.3 ^a (5.6) ¹	105	42.4 ¹	157	80.0 ³
20	6.1 ^b (6.2) ¹	105	38.9 ³	165	82.6 ³
25	6.8 ^c	116	49.0 ³	175	86.5 ³
30	7.7	120	59.0	182	88.8 ³
40	9.3	123	55.3 ³	195	91.4 ³
50	11.4	129	61.5 ³	206	93.0 ³
60	14.4	133	65.1 ³	235	96.0 ³
70	18.8 ¹				

¹Eddy and Menzies, 1940; see table below for further data.

²Tourneux, 1919.

³Benrath, Gjedebø, Schiffers and Wunderlich, 1937.

^adensity = 1.406; ^bdensity = 1.052; ^cdensity = 1.056; ^ddensity = 1.194;

^edensity = 1.348; Other densities: 34° = 1.068²; 56° = 1.109²

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC CHLORIDE IN WATER AND DEUTERIUM OXIDE (Eddy and Mensies, 1940)

The authors used small closed vessels containing about one gram of solvent. The D_2O was 99.4% pure, as determined from its melting point. (including corrections for the volume of solvent in the vapor phase, the authors estimate the accuracy of the results as 1%. The authors plotted their experimental points and read the following data from the curve. The original data are in terms of moles of salt per 55.51 mols. of solvent.

t°	Gms. $HgCl_2$ per 100 gms.		t°	Gms. $HgCl_2$ per 100 gms.	
	H_2O	D_2O		H_2O	D_2O
0	4.66	2.44	55	15.11	10.40
5	5.00	2.93	60	17.37	12.10
10	5.43	3.42	65	20.04	13.90
15	5.97	3.91	70	23.15	15.90
20	6.59	4.39	75	26.7	18.26
25	7.30	4.93	80	30.9	21.1
30	8.14	5.52	85	35.95	24.55
35	9.09	6.18	90	41.9	28.7
40	10.20	6.94	95	48.9	33.6
45	11.56	7.84	100	58.3	39.95
50	13.19	8.95	105	73.4	49.2

SOLUBILITY OF MERCURIC CHLORIDE IN HYDROCHLORIC ACID SOLUTIONS

0° (Engel, 1889)			25° (Thomas, 1939)			20-25°? (Ditte, 1881)	
Gms. per 100 cc Sol.		Sp. Gr. of Solutions	Moles per 1000 gms. H_2O			Gms. HCl per 100 gms. H_2O	Gms. $HgCl_2$ per 100 gms. sat. sol.
HCl	$HgCl_2$		HCl	$HgCl_2$	d_{25}^4		
1.57	13.11	1.117	0.0	0.2702	1.0563	0.0	6.8
3.61	26.85	1.238	0.1	0.376	1.0801	5.6	46.8
6.49	48.2	1.427	0.2	0.481	1.1035	10.1	73.7
9.81	75.5	1.665	0.3	0.586	1.1266	13.8	87.8
11.76	93.5	1.811	0.5	0.795	1.1728	21.1	127.4
12.48	98.4	1.874	1.0	1.325	1.2823	31.0	141.9
15.13	116.	2.023	2.0	2.420	1.4814	50.0	148.0
17.54	120.	2.066	3.0	3.557	1.6598	68.0	154.0
25.84	129.2	2.198	4.0	4.726	1.8253		
			5.0	5.901	1.9774		
			6.0	7.054	2.1101		
			7.0	8.176	2.2261		
			8.0	9.264	2.3283		
			9.0	10.309	2.4193		

THE SYSTEM MERCURIC CHLORIDE - YELLOW MERCURIC OXIDE - WATER AT 35°
(Tods, 1921)

The various mixtures were rotated in a thermostat for about 72 hours, and both the clear solution and solid phases were analyzed.

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HgCl ₂	HgO		HgCl ₂	HgO	
8.58	0.0	HgCl ₂	0.61	0.02	HgCl ₂ ·4HgO
8.72	0.14	" + HgCl ₂ ·2HgO	0.23	0.03	"
8.68	0.07	" "	0.20	0.06	"
8.69	0.10	" "	0.13	0.04	" + HgO Cl
8.81	0.03	" "	0.07	0.04	" "
8.70	0.11	" "	0.05	0.03	" "
8.69	0.10	" "	0.05	0.04	" "
4.39	0.09	HgCl ₂ ·2HgO	0.04	0.04	HgO
3.42	0.06	"	0.01	0.03	"
0.66	0.02	"	0.00	0.001	"
0.66	0.02	" + HgCl ₂ ·4HgO			

Data for equilibrium in the system HgCl₂ + KOH + H₂O at 25° are given by Herz, 1910.

THE SYSTEM MERCURIC CHLORIDE - MERCURIC IODIDE - WATER
(Sugdan, 1929)

Suitable mixtures of the two salts in water were heated to 100° and then rapidly filtered. The solutions thus obtained, from which solids separate, were rotated up to 11 days. It was necessary to operate in this manner since equilibrium is established too slowly if solids are present from the beginning. Due to analytical difficulties great accuracy is not claimed for the results. The solid phase in the iodide region consists of two series of mixed crystals which are respectively yellow and red. They correspond to the yellow and red form of the simple iodide stable above and below 129°.

Results at 30°			Results at 70°		
Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HgCl ₂	HgI ₂		HgCl ₂	HgI ₂	
7.55	0.0	W	19.12	0.0	W
7.67	0.41	"	19.5	0.44	"
7.75	0.21	"	20.5	1.10	Y
7.77	0.43	" + R	19.8	1.02	"
7.72	0.54	R	17.4	0.99	"
7.69	0.46	"	16.7	1.00	"
6.75	0.31	"	17.8	0.99	"
5.32	0.28	"	12.6	0.94	"
3.39	0.33	"	10.2	0.91	" + R
2.20	0.18	"	9.9	0.84	" + R
7.82	0.52	Y	7.35	0.75	R
5.36	0.37	"	3.94	0.52	"

W = White, R = Red, Y = Yellow.

Hg HYDRARGYRUM

SOLUBILITY OF HgCl_2 in $\text{Hg}(\text{NO}_3)_2$ SOLUTIONS (Morse, 1902)

One liter of 0.1 N $\text{Hg}(\text{NO}_3)_2$ solution dissolves 105 gms. HgCl_2 at 25° .

This result, together with distribution experiments, show that complexes of HgCl_2 and $\text{Hg}(\text{NO}_3)_2$ are formed.

THE SYSTEM MERCURIC CHLORIDE - POTASSIUM CHLORIDE - WATER

Results at 20°

(Tichomirow, 1907)

Results at 25°

(Foote, and Levy, 1906) (Herz and Paul, 1913)

C1

Gms. per 100 Gms. H ₂ O		Solid Phase	Gms. per gms. sat. sol.		Solid Phase	Mols. per Liter					
KCl	HgCl ₂		KCl	HgCl ₂		KCl	HgCl ₂				
0.0	7.39	Hg	26.46	0.0	K	0	0.265				
1.12	11.63	"	26.33	15.02	" + 1:2:1	0.1	0.381*				
2.39	15.72	"	23.74	18.91	1:2:1	0.174	0.355				
4.05	22.17	"	22.36	21.39	"	0.221	0.381				
4.84	25.16	" + 2:1	21.39	23.88	"	0.25	0.542*				
5.60	25.13	2:1	20.29	27.49	" + 1:1:1	0.683	0.836				
6.71	25.66	"	17.85	25.34	1:1:1	*Sherrill, 1903					
7.39	26.41	" + 1:1	9.26	18.95	"						
7.46	24.70	1:1	7.80	19.56	"	" + 2:1:2					
8.95	19.93	"	6.84	22.81	"						
15.00	22.87	"	6.66	24.32	"	2:1:2					
17.57	26.12	"	6.58	25.14	"						
20.35	29.00	"	6.27	25.11	2:1:2	" + Hg					
26.31	34.83	"	5.77	24.73	"						
30.32	39.10	"	4.68	24.88	"	Hg					
34.12	42.82	" + 1:2	0.0	6.90	"						
34.18	39.34	1:2	Hg = HgCl ₂		K = KCl						
34.34	35.16	"									
35.54	30.63	"	2:1 = 2HgCl ₂ ·KCl		2:1:2 = 2HgCl ₂ ·KCl·2H ₂ O						
37.72	24.30	"	1:1 = HgCl ₂ ·KCl		1:1:1 = HgCl ₂ ·KCl·H ₂ O						
41.33	19.33	" + K	1:2 = HgCl ₂ ·2KCl		1:2:1 = HgCl ₂ ·2KCl·H ₂ O						
39.66	15.76	K									
37.87	10.28										
35.32	2.1										

Results at 34° (and higher) (Tournoux, 1919)

Results similar to these are given for 56° , 80° and 100° .

In a later paper by Tournoux, 1934, having for its object an explanation of the variation in the solubility of HgCl_2 in aq. solutions of KCl and vice versa, the author calculates the equilibrium constants involved and finds that they vary with the temperature in accordance with the law of Van't Hoff.

d of sat. sol.	Gms. per 100 gas. sat. sol.		Solid Phase
	HgCl ₂	KCl	
1.068	8.55	0.0	HgCl ₂
1.202	19.14	2.6	"
-	27.2	4.2	"
-	34.1	5.4	"
1.497	37.0	6.0	"
1.512	37.4	6.0	" + 2HgCl ₂ ·KCl·2H ₂ O
1.525	37.8	6.5	2HgCl ₂ ·KCl·2H ₂ O
1.533	37.7	6.7	"
1.545	37.6	7.3	"
1.549	37.8	7.45	" + 3HgCl ₂ ·2KCl· $\frac{2}{3}$ H ₂ O Cl
1.534	37.4	7.8	3HgCl ₂ ·2KCl· $\frac{2}{3}$ H ₂ O
1.530	37.6	8.0	"
1.524	36.8	8.2	" + HgCl ₂ ·KCl· $\frac{3}{4}$ H ₂ O
1.512	35.9	8.2	HgCl ₂ ·KCl· $\frac{3}{4}$ H ₂ O
1.486	34.5	8.5	"
1.386	27.9	9.6	"
1.368	25.5	11.4	"
1.428	26.8	14.9	"
1.561	30.8	20.0	"
1.620	32.6	22.0	"
1.624	33.0	21.0	" + HgCl ₂ ·2KCl·H ₂ O
1.621	32.8	21.0	HgCl ₂ ·2KCl·H ₂ O
-	29.0	23.0	"
-	24.5	24.8	"
1.459	20.65	26.0	" + KCl
-	17.8	26.8	KCl
-	12.2	27.1	"
-	8.4	27.3	"
-	4.5	27.5	"
-	0.0	27.8	"

Data for the system $\text{HgCl}_2 + \text{KCl} + \text{H}_2\text{O}$ at 25° are given by Osaka and Ando 1924, 1925, 1926.

THE SYSTEM MERCURIC CHLORIDE - SODIUM CHLORIDE - WATER

Results at 10°

(Foote and Levy, 1906)	
Gas. per 100 gas. sol'n.	
NaCl	HgCl ₂
19.46	46.49
19.48	46.50

Results at 25°

(Foote and Levy, 1906)		(Here and Paul, 1913)	
Gas. per 100 Gas. Solution		Mole. per Liter	
NaCl	HgCl ₂	NaCl	HgCl ₂
26.5	0.0	0.201	0.372
18.71	51.32	0.416	0.508
14.97	57.74	0.671	0.748
14.03	59.69	1.153	1.192
13.25	62.16	1.941	2.022
13.17	62.59	3.162	3.434
13.08	62.50	" + HgCl ₂	
1:1:2 = HgCl ₂ ·NaCl·2H ₂ O			

100 gas. of aqueous 1.0 normal NaCl solution dissolve 25.08 gas. HgCl₂ at 25°. (Osaka, 1903-08)

(Contd.)

Hg HYDRARGYRUM

Results at 15°, 65°, 100°
(Homeyer and Ritsert, 1888)

Per cent Concentration of NaCl Solutions	Gms. HgCl ₂ per 100 Gms. NaCl Solution at:		
	15°	65°	100°
0.5	10	13	44
1.0	14	18	48
5.0	30	36	64
10.0	58	68	110
25.0	120	142	196
26.0 (saturated)	128	152	208

Cl 0.2 gms. HgCl₂ dissolve in 1 cc. of sea water of pH = 8.1 at 25°.
(Ferry and Riley, 1946)

THE SYSTEM MERCURIC CHLORIDE - AMMONIUM CHLORIDE - WATER AT 30°
(Meerburg, 1908)

Gms. per 100 Gms. Sat. Sol.		Solid Phase	Gms. per 100 Gms. Sat. Sol.		Solid Phase
HgCl ₂	NH ₄ Cl		HgCl ₂	NH ₄ Cl	
0	29.50	NH ₄ Cl	57.05	9.92	3.2.1
22.80	26.91	"	58.65	9.20	" + 9.2
42.45	25.05	"	*51.83	8.76	9.2
50.05	24.79	" + 1.1.1	*46	7.52	"
53.08	22.77	1.2.1	*35.60	5.26	"
58.90	20.02	" + 1.1.1	*32.90	5.06	"
56.38	18.50	1.1.1	29.65	3.62	" + HgCl ₂
55.58	16.82	"	40.12	5.13	HgCl ₂
57.01	14.12	" + 3.2.1	21	2.29	"
56.26	13.04	3.2.1	7.67	0	"

1.2.1 = HgCl₂·2NH₄Cl·H₂O; 1.1.1 = HgCl₂·NH₄Cl·H₂O;

3.2.1 = 3HgCl₂·2NH₄Cl·H₂O; 9.2 = 9HgCl₂·2NH₄Cl.

*In these solutions 2 to 3 weeks were required for attainment of equilibrium.

THE SYSTEM MERCURIC CHLORIDE - RUBIDIUM CHLORIDE - WATER AT 25°
(Foote and Levy, 1906)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
RbCl	HgCl ₂		RbCl	HgCl ₂	
48.57	0.0	RbCl	10.06	9.86	4RbCl·HgCl ₂ ·H ₂ O
47.55	9.39	RbCl+2RbCl·HgCl ₂ ·H ₂ O	8.48	8.71	"
47.65	10.35	2RbCl·HgCl ₂ ·H ₂ O	8.46	8.80	"
35.16	19.58	"	5.68	8.70	"
34.77	19.94	" + 3RbCl·2HgCl ₂ ·2H ₂ O	5.10	8.33	"
30.27	20.17	3RbCl·2HgCl ₂ ·2H ₂ O	3.43	8.25	" + RbCl·5HgCl ₂
29.20	20.55	"	2.98	7.71	RbCl·5HgCl ₂
27.38	20.63	"	1.89	7.64	"
26.83	20.87	" + RbCl·HgCl ₂ ·H ₂ O	1.50	7.55	"
26.15	20.58	RbCl·HgCl ₂ ·H ₂ O	1.10	7.21	"
23.81	18.71	"	0.79	7.16	" + HgCl ₂
18.10	14.25	"	0.0	6.90	HgCl ₂
10.87	10.42	"			
10.68	10.56	" + 4RbCl·3HgCl ₂ ·H ₂ O			

SOLUBILITY OF MERCURIC CHLORIDE IN LITHIUM CHLORIDE SOLUTIONS
(Results at 25°)

(Barr and Paul, 1913)		(Thomas, 1939)					
Mols. per liter		Moles per 1000 gms. H ₂ O			Moles per 1000 gms. H ₂ O		
LiCl	HgCl ₂	LiCl	HgCl ₂	density $\frac{g}{cc}$	LiCl	HgCl ₂	density $\frac{g}{cc}$
0.414	0.351	0.0	0.2702	1.0563	2.0	2.177	1.4516
0.835	0.666	0.1	0.375	1.0801	3.0	3.145	1.6169
1.271	1.021	0.2	0.475	1.1031	4.0	4.134	1.7661
1.738	1.678	0.3	0.572	1.1257	5.0	5.132	1.9003
2.265	2.214	0.5	0.761	1.1684	6.0	6.131	2.0206
3.091	2.896	1.0	1.230	1.2693	7.0	7.120	2.1287
					8.0	8.097	2.2251

Cl

Results at 30°
(Bliden, 1954)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
LiCl	HgCl ₂		LiCl	HgCl ₂	
47.16	0.0	LiCl·H ₂ O	22.70	38.05	LiCl·H ₂ O + HgCl ₂
44.05	2.53	"	21.66	37.80	HgCl ₂
41.48	5.61	"	18.21	35.29	"
38.47	9.62	"	14.07	31.22	"
34.10	16.07	"	8.60	25.53	"
30.39	22.50	"	5.36	21.75	"
27.03	29.24	"	0.0	6.92	"
23.90	36.08	"			

THE SYSTEM MERCURIC CHLORIDE - MAGNESIUM CHLORIDE - WATER AT 25°
(Bassett, Barton, Foster and Pateman, 1933)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
HgCl ₂	MgCl ₂		HgCl ₂	MgCl ₂		HgCl ₂	MgCl ₂	
6.90	0.0	HgCl ₂	53.15	16.30	B	44.93	21.12	C
33.47	5.4	"	51.88	17.27	"	43.20	21.95	" + D
47.72	8.28	"	50.08	18.77	" + C	41.66	22.43	D
56.03	9.86	"	49.85	19.23	B	31.92	25.29	D
57.46	10.68	"	49.47	19.07	C	24.29	27.64	"
59.23	12.48	" + B	48.95	19.22	"	11.76	31.72	"
55.90	14.44*	B	48.78	19.45	"	0.58	35.48	"
55.78	14.38	"	47.32	20.01	"	0.0	35.70	"
54.53	15.24	"	45.45	20.90	"			

*Metestable

B = [Mg(H₂O)₆] [Hg₂Cl₆]; C = [Mg(H₂O)₆] [HgCl₄]; D = [Mg(H₂O)₆] Cl₂.

(Contd.)

Hg HYDRARGYRUM

Data of Herz and Paul,
1913 at 25°:

Mols. per Liter		Mols. per Liter	
MgCl ₂	HgCl ₂	MgCl ₂	HgCl ₂
0.168	0.374	0.997	1.864
0.415	0.719	1.320	2.569
0.570	1.131	1.728	3.206

THE SYSTEM MERCURIC CHLORIDE - STRONTIUM CHLORIDE - WATER AT 25°
(Bassett, Barton, Foster and Pateman, 1933)

Cl	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
	HgCl ₂	SrCl ₂		HgCl ₂	SrCl ₂		HgCl ₂	SrCl ₂	
	6.90	0.0	HgCl ₂	56.20	19.20	B + S	0.0	40.0*	D
	34.70	9.30	"	55.45	19.82	"	48.20	23.60	E
	48.21	13.93	"	54.33	20.88	"	46.25	24.02	"
	56.62	16.65	"	52.70	21.90	"	45.32	24.26	"
	57.17	17.34	"	51.20	22.50	"	34.52	26.78	"
	58.38	18.02	" + B + S	50.87	22.98	"	31.02	27.50	"
	58.68	18.47*	" + C	48.90	23.69	" + E	18.82	30.50	"
	58.49	19.42*	C	48.81	24.01	"	8.55	33.42	"
	59.49	19.66*	"	48.77	23.90*	"	0.0	35.84	"
	58.13	18.00	B + S						

*Metastable

B = [Sr(H₂O)₈][(HgCl₂)₃Cl₂]; C = [Sr(H₂O)₆][(HgCl₂)₆Cl₂]; D = SrCl₂·2H₂O;
E = SrCl₂·6H₂O; S = Solid solution.

Data of Herz and Paul,
1913 at 25°:

Mols. per Liter		Mols. per Liter	
SrCl ₂	HgCl ₂	SrCl ₂	HgCl ₂
0.164	0.315	0.724	1.342
0.311	0.563	1.046	1.776
0.519	0.829	1.384	2.293

SOLUBILITY OF MERCURIC CHLORIDE IN BARIUM, CALCIUM AND ALUMINUM
CHLORIDE SOLUTIONS AT 25°

In Aq. CaCl₂
(Herz and Paul, 1913)

Mols. per Liter	
CaCl ₂	HgCl ₂
0.190	0.364
0.402	0.766
0.656	1.108
0.964	1.811
1.429	2.645
1.723	3.304

(Contd.)

SOLUBILITY OF MERCURIC CHLORIDE IN BARIUM, CALCIUM AND ALUMINUM
CHLORIDE SOLUTIONS AT 25°--Contd.

In Aq. CaCl_2
(Thomas, 1939)

Moles per 1000 gms. H_2O		d_{25}^4
CaCl_2	HgCl_2	
0.0	0.2702	1.0563
0.05	0.375	1.0821
0.10	0.478	1.1074
0.15	0.573	1.1318
0.25	0.762	1.1788
0.50	1.239	1.2907
1.0	2.207	1.4960
1.5	3.185	1.6805
2.0	4.164	1.8429
2.5	5.144	1.9878
3.0	6.123	2.1111

In Aq. CaCl_2 - LiCl [$\text{LiCl}/\text{CaCl}_2 = 2.0013$]
(Thomas, 1939)

Moles per 1000 gms. H_2O		
Cl ⁻ from added Salts	HgCl_2	d_{25}^{25}
0.0	0.2702	1.0563
0.1	0.376	1.0795
0.2	0.478	1.1026
0.3	0.576	1.1256
0.5	0.763	1.1708
1.0	1.233	1.2790
2.0	2.188	1.4767
3.0	3.162	1.6515
4.0	4.145	1.8071
5.0	5.132	1.9449
6.0	6.121	2.0695
7.0	7.111	2.1816

Cl

In Aq. BaCl_2
(Herz and Paul, 1913)

Mols. per Liter		Mols. Per Liter	
BaCl_2	HgCl_2	BaCl_2	HgCl_2
0	0.265	0.776	1.620
0.385	0.697	1.336	2.645
0.572	1.167	3.030	5.348

In Solutions containing AlCl_3
(Thomas, 1939)

Moles [Cl ⁻] from added Salt per 1000 gms. H_2O	AlCl_3		$\text{LiCl} - \text{AlCl}_3^*$	
	Moles HgCl_2 per 1000 gms. H_2O	d_{25}^4	Moles HgCl_2 per 1000 gms. H_2O	d_{25}^4
0.0	0.2702	1.0563	0.2702	1.0563
0.1	0.373	1.0816	0.375	1.0798
0.2	0.471	1.1057	0.475	1.1030
0.3	0.568	1.1293	0.572	1.1263
0.5	0.758	1.1753	0.762	1.1714
1.0	1.235	1.2864	1.231	1.2781
2.0	2.196	1.4899	2.189	1.4715
3.0	3.175	1.6762	3.158	1.6457
4.0	4.132	1.8419	4.133	1.8013
5.0	5.044	1.9848	5.104	1.9418

* $\text{LiCl}:\text{AlCl}_3 = 2.9990$

SOLUBILITY OF MERCURIC CHLORIDE IN ABSOLUTE ALCOHOLS
(Etard, 1894)

[Methyl, Ethyl, Propyl, n-Butyl, iso-Butyl, Allyl]

Data in agreement with these are given for:

Methyl, Ethyl, propyl alcohols - room temperature - Hohland (1898)
 " " " " - 8.5°, 20°, 38.2° - Timofejew (1891)
 Methyl, Ethyl alcohols -25° - de Bruyn (1892)

Grams HgCl_2 per 100 Grams Saturated Solution in:

t°	CH_3OH	$\text{C}_2\text{H}_5\text{OH}$	$\text{C}_3\text{H}_7\text{OH}$	$\text{CH}_3(\text{CH}_2)_3\text{OH}$	$(\text{CH}_3)_2\text{CHCH}_2\text{OH}$	$\text{CH}_2=\text{CH}\cdot\text{CH}_2\text{OH}$
-30	...	14.5	15.0	...	...	...
-20	...	20.1	15.7	13.5	...	21.0
-10	15.2	26.5	16.5	13.7	...	25.5
0	20.1	29.8	17.4	14.0	5.2	30.0
+10	26.3	30.6	18.0	14.3	6.0	37.5
20	34.0	32.0	18.8	14.6	6.8	46.5
25	40.0	32.5	19.5	15.5	7.2	...
30	44.4	33.7	20.0	16.5	7.5	...
40	58.6	35.6	23.0	19.6	9.7	...
60	62.5	41.2	29.8	26.5	17.0	...
80	66.0	47.5	36.8	33.0	24.9	...
100	70.1	54.3	43.8	...	31.7	...
120	73.5	61.5	50.6	...	39.2	...
150	78.5	...	...	...	...	...
Crit.						
Temp.	1.2*					

*Centnerssver, 1910.

SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS METHYL ALCOHOL AT 25°
(Hers and Anders, 1907)

Wt. % CH_3OH in Solvent	d_{25}^4 of Solvent	d_{25}^4 of Sat. Sol.	Gms. HgCl_2 per 100 cc Sat. Sol.
10.60	0.9792	1.0441	7.90
30.77	0.9481	1.0420	11.31
37.21	0.9369	1.0507	13.43
47.06	0.9186	1.0809	19.71
64	0.8800	1.2015	38.44
78.05	0.8489	1.3314	57.17
100	0.7879	1.2160	48.62

SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS ETHYL ALCOHOL

Results at 18°
(Laird, 1920)

Wt. % C_2H_5OH in Solvent	Gms. $HgCl_2$ per 100 gms. sat. sol.	Wt. % C_2H_5OH in Solvent	Gms. $HgCl_2$ per 100 gms. sat. sol.
0	6.24	25.0	5.08
10.0	5.63	30.0	5.86
15.0	5.43	40.0	7.58
20.0	5.15	51.0	11.30

100 cc 90% ethyl alcohol dissolve 27.5 gms. $HgCl_2$ at 15.0°, d_{15} sat. sol. = 1.065. (Greenish and Smith, 1903)

Cl

Results at 25°

(Abe, 1912)

Solid phase = $HgCl_2$

(Herz and Anders, 1907)

[Somewhat lower than those at left]

Gms. per 100 Gms. Sat. Sol.				Wt. % C_2H_5OH in Solvent	d_{25}^{25} of Sat. Sol.	Gms. $HgCl_2$ per 100 cc Sat. Sol.
C_2H_5OH	$HgCl_2$	C_2H_5OH	$HgCl_2$			
0.0	6.80	45.85	15.36	0	1.0565	7.22
5.08	6.65	49.86	18.18	20.18	1.0214	6.76
14.49	6.41	53.61	21.40	40.69	1.0180	10.69
21.00	6.55	57.26	24.51	70.01	1.0616	23.60
26.25	7.31	60.55	27.67	100	1.1067	36.86
31.53	8.51	63.95	29.86			
36.85	10.32	67.39	32.40			
41.36	12.64					

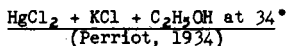
100 gms. 99.2% ethyl alcohol dissolve 33.4 gms. $HgCl_2$ at 25°.
(Osaka, 1903-8)

THE SYSTEMS $HgCl_2$ - KCl - ETHANOL AND $HgCl_2$ - NaCl - ETHANOL $HgCl_2$ + KCl + C_2H_5OH at 25°
(Foote, 1910)

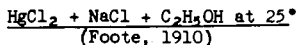
[For data in acetone, see p. 1223.]

Gms. per 100 Gms. Sat. Solution		Solid Phase
KCl	$HgCl_2$	
0.21	33.69	$HgCl_2 + 5KCl \cdot 6HgCl_2 \cdot 2C_2H_5OH$
0.28	33.80	" "
0.22	24.84	$5KCl \cdot 6HgCl_2 \cdot 2C_2H_5OH$
0.28	6.21	" "
0.25	1.65	$5KCl \cdot 6HgCl_2 \cdot 2C_2H_5OH + KCl$
0.17	1.57	" "
0.38	1.03	" "

(Contd.)

THE SYSTEMS HgCl_2 - KCl - ETHANOL AND HgCl_2 - NaCl - ETHANOL--Contd.

The solid phase in contact with solutions of Mercuric Chloride plus Potassium Chloride in 95% or absolute ethyl alcohol at 34° was found to be $6\text{HgCl}_2 \cdot 5\text{KCl} \cdot 2\text{C}_2\text{H}_5\text{OH}$.



100 gms. of sat. abs. alcohol solution of $\text{HgCl}_2 + \text{NaCl}$ contain 46.85 gms. HgCl_2 and 3.01 gms. NaCl at 25° . For data in acetone, see p

C1

1 part of HgCl_2 is soluble in 3.7 parts of $\text{C}_2\text{H}_5\text{OH}$ denatured with methanol, pyridine, and mineral naphtha (mineralized methylated spirit).
(Stout, 1945)

1 part of HgCl_2 is soluble in 13 parts of Isopropyl alcohol.

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND AMYL ALCOHOL
(Wosnessensky and Astechow, 1927)

Mols. HgCl_2 per liter		Conc. in H_2O
Water	Amyl Alcohol	Conc. in Amyl Alcohol
0.0072	0.013	0.554
0.0378	0.072	0.525
0.0688	0.139	0.495

SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ALCOHOLS AT 25°
(Herz and Kuhn, 1908)

In Mixtures of Ethyl and Methyl Alcohols			In Mixtures of Ethyl and Propyl Alcohols		
% CH_3OH in Solvent	d_{25}^4 of Sat. Sol.	Gms. HgCl_2 per 100 cc Sat. Sol.	% $\text{C}_3\text{H}_7\text{OH}$ in Solvent	d_{25}^4 of Sat. Sol.	Gms. HgCl_2 per 100 cc Sat. Sol.
0	1.107	36.86	0	1.1070	36.86
4.37	1.130	39.43	8.1	1.0988	36.67
10.40	1.157	42.61	17.85	1.0857	34.06
41.02	1.294	58.37	56.6	1.0272	27.11
80.69	1.321	61.67	88.6	0.9854	21.66
84.77	1.288	57.82	91.2	0.9824	21.60
91.25	1.254	53.85	95.2	0.9772	20.87
100	1.216	48.62	100	0.9720	20.03

In Mixtures of Methyl and Propyl Alcohols		
% $\text{C}_3\text{H}_7\text{OH}$ in Solvent	d_{25}^4 of Sat. Sol.	Gms. HgCl_2 per 100 cc Sat. Sol.
0	1.2160	48.62
11.11	1.2278	50.34
23.80	1.2848	57.14
65.20	1.1568	42.28

% $\text{C}_3\text{H}_7\text{OH}$ in Solvent	d_{25}^4 of Sat. Sol.	Gms. HgCl_2 per 100 cc Sat. Sol.
91.80	1.0090	25.09
93.75	1.0029	23.23
96.6	0.9851	21.52
100	0.9720	20.03

SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ALCOHOLS
AND OTHER SOLVENTS
(Dukelski, 1907)

In a Mixture of one mol. CH_3OH + one mol. CHCl_3		In a Mixture of two mols. CH_3OH + one mol. CHCl_3		In a Mixture of two mols. CH_3OH + one mol. $\text{C}_2\text{H}_4\text{Cl}_2$		Cl
t°	Gms. HgCl_2 per 100 Gms. Sat. Sol.	t°	Gms. HgCl_2 per 100 Gms. Sat. Sol.	t°	Gms. HgCl_2 per 100 Gms. Sat. Sol.	
-12	1.73	-12	3.33	0	5.20	
0	3.51	0	6.73	7.7	6.69	
8	5.63	8	8.21	24.9	14.06	
23	10.15	23	16.56	30.6	19.40	
24.9	10.71	24.9	18.45	35.5	20.50	
30.6	11.40	30.6	19.70	36.1	21.80	
38.5	12.02	38.5	20.83	48.5	21.90	
In a Mixture of two mols. CH_3OH + one mol. $\text{C}_2\text{H}_4\text{Cl}_2$		In a Mixture of one mol. $\text{C}_2\text{H}_5\text{OH}$ + one mol. C_6H_6		In a Mixture of two mols. $\text{C}_2\text{H}_5\text{OH}$ + one mol. C_6H_6		
0	13.33	- 2.5	15.20	-5.2	19.45	
12.5	21.30	0	15.40	0	20.13	
20.8	29.23	6	16.38	9.1	21.65	
25.3	34.78	20.5	18.40	20.9	23.57	
30.2	36.87	20.65	18.50	24.4	24.19	
37.4	37.95	24.5	19.33	36.5	26.53	
45.9	39.36	34.5	21.34	53.7	31.27	
		54.4	24.84	74	38.74	
		54.5	24.42			
In a Mixture of one mol. $\text{C}_2\text{H}_5\text{OH}$ + one mol. CHCl_3		In a Mixture of two mols. $\text{C}_2\text{H}_5\text{OH}$ + one mol. CHCl_3				
-20.5	3.82	-20.5	6.60			
-12	4.43	0	7.69			
0	4.89	8	8.96			
8	5.37	23	10.66			
23	7.12	38.5	12.50			
38.5	8.51	44.2	14.40			
44.2	9.51					
45.6	9.98					

Some of the determinations were made by the direct method of saturating the solution at a given temperature and determining the dissolved material by evaporating and weighing. Others were made by the synthetic method of Alexejew.

(Contd.)

Hg HYDRARGYRUM

(Results of Timofeiew, 1894)

In a Mixture of one mol. CH ₃ OH + one mol. C ₆ H ₆		In a Mixture of one mol. CH ₃ OH + two mols. C ₆ H ₆	
t°	Gms. HgCl ₂ per 100 Gms. Sat. Sol.	t°	Gms. HgCl ₂ per 100 Gms. Sat. Sol.
0	8	0	4.8
21-25	23.9	21-25	17.1
30	27.3	30	18
37	28.1	37	18.4

(Results of Abe, 1912)

Cl

In mixtures of Ethanol + Ethyl Ether at 25°

Gas. per 100 Gms. Sat. Sol.		Gas. per 100 Gms. Sat. Sol.	
HgCl ₂	C ₂ H ₅ OH	HgCl ₂	C ₂ H ₅ OH
32.43	67.57	36.29	27.16
35.50	58.59	34.08	22.48
37.39	51.02	28.55	15.20
37.96	44.79	20.67	8.97
38.24	38.69	5.49	0
37.75	32.84		

THE SYSTEM MERCURIC CHLORIDE - DIOXANE - WATER AT 25°
(Laurent, Hagerauller and Dang-Quoc-Quan)

Gms. per 100 gms. sat. sol.		Solid Phase	Gas. per 100 gms. sat. sol.		Solid Phase
HgCl ₂	C ₄ H ₈ O ₂		HgCl ₂	C ₄ H ₈ O ₂	
6.9	0.0	HgCl ₂	0.15	46.3	1:1 + 1:2
6.9	0.7	" + 1:1	2.55	94.6	1:2
0.8	20.5	1:1	2.2	97.8	1:2

1:1 = HgCl₂·C₄H₈O₂

1:2 = HgCl₂·2C₄H₈O₂

SOLUBILITY OF MERCURIC CHLORIDE IN ABSOLUTE ETHYL ETHER
(Etard, 1894; Lasacynski, 1894; Köhler, 1879)

t°	Gms. HgCl ₂ per 100 Gms. Solution	t°	Gms. HgCl ₂ per 100 Gms. Solution	t°	Gms. HgCl ₂ per 100 Gms. Solution
-20	6	60	6	90	7.5
0	6	70	6.4	100	8
20	6 (6.49)*	80	7	110	8.5

*Richard, 1926 (= 5.0 gms. HgCl₂ per 100 cc ether)

SOLUBILITY OF MERCURIC CHLORIDE IN WATER-ETHER MIXTURES AT 25°
(Abe, 1912)

Gms. per 100 Gms. Sat. Sol.			
HgCl ₂	Ether	H ₂ O	Solid Phase
6.92	87.86	5.22*	HgCl ₂
5.2	1.2	93.6	"
4.3	5.2	90.5	"
2.8	5.4	91.8	"
1.5	5.4	93.1	"

*(Solvent, ether sat. with H₂O.)

Cl

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND ETHER
(Hantzsch and Sebalt, 1899)

50 cc. ether + 50 cc. sat. aqueous HgCl₂ solution were shaken together at different temperatures and after equilibrium was established the HgCl₂ in each layer determined.

t°	Mols. HgCl ₂ per Liter:		$\frac{c^1}{c^2}$
	H ₂ O Layer (c ¹)	(C ₂ H ₅) ₂ O Layer (c ²)	
0	0.0056	0.01407	0.391
10	0.0066	0.01415	0.467
17.5	0.0090	0.02150	0.419
25	0.0095	0.02076	0.429

Determinations by Skinner (1892) at room temp. using concentrations of HgCl₂ in the aqueous layer varying from 1.4 to 5.9 per cent, gave a distribution coefficient, $\frac{c_1}{c_2}$ = approximately 0.23.

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN AQUEOUS HCl AND ETHER AT 18°
(Mylius, 1911)

When 1 gm. of Hg as HgCl₂ is dissolved in 100 cc of H₂O or aqueous HCl and shaken with 100 cc of ether, the percentage of the Hg which goes into the ethereal layer is as follows:

Percentage Conc. of Aq. HCl	0 (= H ₂ O)	1	10	20
Per cent Hg in Ether Layer	69.4	13	0.4	0.2

SOLUBILITY OF DOUBLE MERCURIC CHLORIDES IN AQUEOUS AND PURE ETHER AT 16.6°
(Strömholm, 1902, 1903)

Mol. Conc. of HgCl_2 per Liter of: Gms. HgCl_2 per Liter of:

Pure Ether	Aq. Ether (1)	Aq. Ether (2)	Aq. Ether (3)	Pure Ether	Aq. Ether (4)	Aq. Ether (5)	Aq. Ether (6)	Solid Phase
0.1515	0.2387	0.2647	0.3196	41.04	64.69	71.71	86.58	HgCl_2
0.0673	0.1157	0.1293	0.1617	18.23	31.41	35.05	43.79	$(\text{CH}_3 \cdot \text{CH}_2\text{C}_2\text{H}_5)_2\text{SCl} \cdot 6\text{HgCl}_2$
0.0404	0.0720	0.0835	0.1034	10.95	19.51	22.61	28.01	$(\text{CH}_3 \cdot \text{C}_2\text{H}_5\text{CH}_2\text{C}_2\text{H}_5)_2\text{SCl} \cdot 6\text{HgCl}_2$
0.0342	...	0.0706	...	9.26	...	19.10	...	$(\text{CH}_3)_4\text{NC1} \cdot 6\text{HgCl}_2$
0.0264	...	0.0568	...	7.14	...	15.39	...	$(\text{C}_2\text{H}_5)_3\text{SC1} \cdot 6\text{HgCl}_2$
0.0209	0.0400	0.0460	0.0594	5.66	10.83	12.48	16.10	$(\text{CH}_3\text{C}_2\text{H}_5)_2\text{SC1} \cdot 6\text{HgCl}_2$
0.0063	...	0.0144	...	1.70	...	3.90	...	$(\text{CH}_3)_2 \cdot \text{H}_2\text{NC1} \cdot 2\text{HgCl}_2$

c1

- (1) containing 0.21055 mol. H_2O per liter. (2) 0.2756 mol. H_2O per liter.
 (3) 0.421 mol. H_2O per liter. (4) containing 3.79 gms. H_2O per liter.
 (5) 4.97 gms. H_2O per liter. (6) 7.59 gms. H_2O per liter.

**SOLUBILITY OF MERCURIC CHLORIDE AND OF DOUBLE MERCURIC AND
TETRA METHYL AMINE CHLORIDE $(\text{CH}_3)_4\text{NC1} \cdot 6\text{HgCl}_2$ IN AQ. ETHER AT 17°**
(Strömholm, 1902, 1903a)

Molecular Concentration per Liter			Grams per Liter of Solution		
H_2O	$\text{HgCl}_2(*)$	$\text{HgCl}_2(\dagger)$	H_2O	$\text{HgCl}_2(*)$	$\text{HgCl}_2(\dagger)$
0.0	0.1515	0.0342	0	41.16	9.26
0.0656	0.1795	0.0428	1.18	48.64	11.60
0.1311	0.2069	0.0516	2.36	56.08	14.00
0.1956	0.2339	0.0603	3.52	63.38	16.34
0.2611	0.2489	0.0690	4.70	70.16	18.70
0.3267	0.2849	0.0779	5.88	77.20	21.10
0.3922	0.3100	0.0866	7.06	84.02	23.48

RESULTS IN ALCOHOL - ETHER SOLUTIONS
(Strömholm, 1903)

Grams $\text{C}_2\text{H}_5\text{OH}$ per Liter Grams $\text{HgCl}_2(*)$ per Liter Grams $\text{HgCl}_2(\dagger)$ per Liter

0.0	41.16	9.26
4.58	50.00	11.87
9.16	58.76	14.88
13.74	66.96	16.90

(*) Results in this column are for solutions in contact with the Solid Phase HgCl_2 .

(†) Results in this column are for solutions in contact with the Solid Phase $(\text{CH}_3)_4\text{NC1} \cdot 6\text{HgCl}_2$.

SOLUBILITY OF MERCURIC CHLORIDE IN BENZENE
(Average curve from results of Linebarger, 1895; Sherrill, 1903;
and Marden and Dover, 1917)
(Also Dukelski, 1907 (D.) and von Laszcynski, 1894 (L.))

[Note the disagreement at higher temperatures]

t*	Gms. HgCl ₂ per 100 gms. sat. sol.	t*	Gms. HgCl ₂ per 100 gms. sat. sol.	t*	Gms. HgCl ₂ per 100 gms. sat. sol.	
0	0.20	20	0.56	41	0.616 (L.)	
6.5	0.26 (D.)	25	0.64	54.1	1.02 (D.)	
10	0.39	30	0.71	55	0.843 (L.)	
15	0.537 (L.)	34.1	0.64 (D.)	69	1.39 (D.)	
18	0.53 (D.)	40	0.84	84	1.769 (L.)	Cl

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND BENZENE
(Linhart, 1915)

Results at 25°

Results at 40°

Mols. HgCl ₂ per Liter:		Conc. in H ₂ O	Mols. HgCl ₂ per Liter:		Conc. in H ₂ O
C ₆ H ₆ Layer	H ₂ O Layer	Conc. in C ₆ H ₆	C ₆ H ₆ Layer	H ₂ O Layer	Conc. in C ₆ H ₆
0.02100	0.2866	13.65	0.02647	0.34600	13.07
0.01224	0.15777	12.91	0.015296	0.18470	12.08
0.005244	0.064756	12.35	0.011774	0.138228	11.74
0.000618	0.007382	11.95	0.008041	0.091959	11.44
0.000310	0.003696	11.90	0.004140	0.04586	11.08
0.000155	0.001845	11.90	0.000847	0.009153	10.81

SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF BENZENE AND OTHER SOLVENTS
(Results of Dukelski, 1907)

In a Mixture of one mol. C ₆ H ₆ + one mol. CH ₃ COOC ₂ H ₅		In a Mixture of one mol. CHCl ₃ + one mol. CH ₃ COOC ₂ H ₅		In a Mixture of one mol. CCl ₄ + two mols. CH ₃ COOC ₂ H ₅	
t*	Gms. HgCl ₂ per 100 Gms. Sat. Sol.	t*	Gms. HgCl ₂ per 100 Gms. Sat. Sol.	t*	Gms. HgCl ₂ per 100 Gms. Sat. Sol.
0	9.62	0	3.34	0	9.24
6.5	9.62	26.1	4.07	10.3	9.05
25.7	9.78	36.1	4.78	25.7	9.32
27.6	9.98	46	5.38	27.6	9.50
35.5	10.81	48.5	5.10	38.5	9.89
45.3	13.69			45.3	11.70

(Contd.)

(Results of Marden and Dover, 1917)

In Mixtures of $\text{CH}_3\text{COCH}_3 + \text{C}_6\text{H}_6$

Gms. CH_3COCH_3 per 100 gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent	Gms. CH_3COCH_3 per 100 gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent
100	140	40	31.4
90	117	30	20
80	96.5	20	10.7
70	77	10	3.9
60	60	0	0.66
50	45		

c1

In Mixtures of $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{C}_6\text{H}_6$

Gms. $\text{CH}_3\text{COOC}_2\text{H}_5$ per 100 gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent	Gms. $\text{CH}_3\text{COOC}_2\text{H}_5$ per 100 gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent
100	49.3	40	8.0
90	26.0	30	5.4
80	22.1	20	3.1
70	18.1	10	1.6
60	14.2	0	0.66
50	11.0		

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND TOLUENE

Results at 24°
(Brown, 1898)

Results at 25°
(Morse, 1902; Drucker, 1912; Hantzsch and Vagt, 1901)

Gms. HgCl_2 per 100 cc.		Mols. HgCl_2 per Liter:		$\frac{c_1}{c_2}$
H_2O Layer	$\text{C}_6\text{H}_5\text{CH}_3$ Layer	H_2O Layer (c_1)	$\text{C}_6\text{H}_5\text{CH}_3$ Layer (c_2)	
0.442	0.0270	0.18410	0.01590	11.6
0.732	0.0488	0.09193	0.00807	11.4
0.780	0.0542	0.04593	0.00410	11.1
1.192	0.0812	0.02289	0.00211	10.8
1.816	0.130	0.01142	0.00108	10.5
3.766	0.292	0.00573	0.00057	10
3.754	0.298			
6.688*	0.528*			

*This solution saturated.

Results at Various Temperatures
(Hantzsch and Vagt, 1901)

t°	Mols. HgCl_2 per Liter:		$\frac{c_1}{c_2}$
	H_2O Layer (c_1)	$\text{C}_6\text{H}_5\text{CH}_3$ Layer (c_2)	
0	0.0578	0.0047	12.35
10	0.0575	0.0050	11.60
20	0.0576	0.0050	11.40
30	0.0574	0.0051	11.20
50	0.0573	0.0052	11.25

(Contd.)

Data for the effect of $\text{Hg}(\text{NO}_3)_2$ upon the distribution of HgCl_2 between H_2O and toluene are given by Morse (1902). Results for the effect of ZnCl_2 are given by Drucker (1912).

SOLUBILITY OF MERCURIC CHLORIDE IN ACETONE

The data are not in good agreement.

Gms. HgCl_2 per 100 Gms. Saturated Solution

t°	Krug and McElroy (1892)	von Laszcynski (1894)	Aten (1905-6)	Etard (1894)	Naumann (1904)	Zapata & Zapata (1930)	Foote (1911)
-10	44.0*	57.0	...	...	...
0	...	49.7	43.0*	61.7	...	...	...
+10	...	52.0	51.0*-58.9	61.7	...	...	...
18	58.9	...	...
20	...	54	58.5	61.7	...	...	...
25	37.4	55.2	58.2	61.7	...	54.9	57.74
30	61.7	...	...	...
40	61.7	...	...	...
50	61.7	...	...	...
60	61.7	...	...	...
80	61.7	...	...	...

Cl

*Solid phase $\text{HgCl}_2(\text{CH}_3)_2\text{CO}$

Solid Phase HgCl_2

THE SYSTEM $\text{HgCl}_2 + \text{KCl} + \text{ACETONE AT } 25^\circ$
(Foote, 1910)

Gms. per 100 Gms. Sat. Solution			Gms. per 100 Gms. Sat. Solution		
KCl	HgCl_2	Solid Phase	KCl	HgCl_2	Solid Phase
1.27	61.87	$\text{HgCl}_2 + \text{KCl} \cdot 5\text{HgCl}_2 \cdot (\text{CH}_3)_2\text{CO}$	2.93	48.13	5.6.2
1.39	60.68	$\text{KCl} \cdot 5\text{HgCl}_2 \cdot (\text{CH}_3)_2\text{CO}$	2.52	18.04	"
2.58	55.85	"	3.34	13.26	"
2.78	54.41	" 5.6.2	2.92	11.00	" KCl

5.6.2 = $5\text{KCl} \cdot 6\text{HgCl}_2 \cdot 2(\text{CH}_3)_2\text{CO}$.

SOLUBILITY OF MERCURIC CHLORIDE IN ETHYL ACETATE

The data are not in good agreement.

Grams HgCl_2 per 100 Grams Saturated Solution

t°	von Laszcynski (1894)	Aten (1905-1906)	Linebarger (1894)	Etard (1894)	Dukelski (1907)	Naumann (1910)
-10	...	23.0	...	40	...	...
0	22.0	23.2	32.0	40	22.9	...
+ 6.5	...	...	...	...	22.7	...
10	22.2	23.5	32.5	40	...	...
18	...	...	...	...	...	32.8
20	22.5	23.4	32.7	40	...	...

(Contd.)

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC CHLORIDE IN ETHYL ACETATE--Contd.

Grams HgCl₂ per 100 Grams Saturated Solution

t°	von Laszcynski (1894)	Aten (1905-1906)	Linebarger (1894)	Etard (1894)	Dukelski (1907)	Naumann (1910)
25	22.7	23.5	33.0	40	...	...
26.1	...	...	...	...	22.8	...
30	23.0	...	33.2	40	...	...
38.5	...	...	...	...	23.5	...
40	23.5	...	33.5	40	...	...
45.3	...	...	...	...	26.4	...
50	24.0	...	33.5	41	...	...
60	24.7	...	...	42.5	...	...
80	26.0	...	...	45.2	...	...
100	...	...	...	48.0	...	...
120	...	...	...	50.8	...	...
150	...	...	...	55.0	...	...

SOLUBILITY OF MERCURIC CHLORIDE IN Aq. ETHYL ACETATE AT 25° (Herz and Anders, 1907)

Wt. % CH ₃ COOC ₂ H ₅ in Solvent	d ₂₅ ⁴ of Solvent	d ₂₅ ⁴ of Sat. Sol.	Gms. HgCl ₂ per 100 cc Sat. Sol.
0	0.9971	1.0565	7.22
4.39*	...	1.0581	7.38
96.76	...	1.2371	41.55
100**	0.884	1.1126	26.42

*Almost sat. with ethyl acetate ** (b.pt. = 75.77°)

Ethyl acetate almost sat. with H₂O.

SOLUBILITY OF MERCURIC CHLORIDE AND SODIUM CHLORIDE IN ETHYL ACETATE AT 40°

For results in ethanol, see p. 1216, in acetone, p. 1223.
(Linebarger, 1894)

Mols. per 100 Mols. Acetate		Gms. per 100 Gms. Acetate		Gms. per 100 Gms. Solution		Solid Phase
NaCl	HgCl ₂	NaCl	HgCl ₂	NaCl	HgCl ₂	
0.8	12.9	0.53	39.7	0.53	28.4	HgCl ₂
2.3	12.4	1.53	38.15	1.51	27.61	"
4.3	16.4	2.85	50.44	2.78	33.54	"
9.1	22.85	6.05	86.14	5.60	46.28	"
18.5	34.9	12.29	107.4	10.95	51.76	"
20.0	40.0	13.29	123.0	11.73	55.18	HgCl ₂ + NaCl

The double-salt (HgCl₂)₂·NaCl is formed under proper conditions.

100 gms. methyl acetate (d₁₅⁴ = 0.935) dissolve 42.6 gms. HgCl₂ at 18°.
(Naumann, 1909)

SOLUBILITY OF MERCURIC CHLORIDE AT 25° IN AQUEOUS SOLUTIONS OF:
(Moles and Marquina, 1914, 1924)

Citric Acid		Tartaric Acid	
Per cent Citric acid in Solvent	Gms. HgCl ₂ per 100 gms. sat. sol.	Per cent Tartaric acid in solvent	Gms. HgCl ₂ per 100 gms. sat. sol.
0.0	6.76	10.0	6.36
10.0	6.63	20.0	5.75
25.0	5.73	25.0	5.36
50.0	3.99	35.0	4.59
		42.5	3.98
		50.0	3.28

Cl

Glycerol*		Sucrose	
Per cent Glycerol in Solvent	Gms. HgCl ₂ per 100 gms. sat. sol.	Per cent Sucrose in solvent	Gms. HgCl ₂ per 100 gms. sat. sol.
5.08	7.20	10.0	7.08
15.1	8.33	25.0	8.05
25.0	9.60	30.0	8.46
35.0	11.10	35.0	8.83
50.18	14.88	40.0	9.14
75.08	26.53	42.5	9.16
100.00	44.22*	47.0	9.68
		55.0	10.14

*100 gms. glycerol dissolve 80 gms. HgCl₂ at 25°. (Moles and Marquina, 1914)
100 gms. glycerol dissolve 8 gms. HgCl₂ ? Hg₂Cl₂ at 15-16°. (Ossendowski,

1907)

100 gms. glycerol of $d = 1.2326 (= 86.5\%)$ dissolve 53.5 gm. HgCl₂ at 20°.
" " " $d = 1.2645 (= 98.5\%)$ " 65.5 " " "
(Holm, 1921, 1922)

SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS SOLUTIONS OF URETHAN AT 25°
(Falitzsch, 1928, 1929)

Gm. Mols. HgCl ₂ per 1000 gms. H ₂ O		Solid Phase
HgCl ₂	NH ₂ COOC ₂ H ₅	
0.27	0.0	HgCl ₂
0.30	1.1225	"
0.607	4.4898	"
1.552	11.326	"
0.25	51.79	" NH ₂ COOC ₂ H ₅

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC CHLORIDE IN ANHYDROUS ACETIC ACID DETERMINED BY THE SYNTHETIC METHOD (Davidson and Chappell, 1938)

t°	Mols. HgCl ₂ per 100 mols. HgCl ₂ + CH ₃ COOH	Solid Phase	t°	Mols. HgCl ₂ per 100 mols. HgCl ₂ + CH ₃ COOH	Solid Phase
16.6	0.0	CH ₃ COOH	53	1.46	HgCl ₂
16.45	0.27	"	60	1.61	"
16.35	0.477	"	66	1.81	"
17.0	0.477	HgCl ₂ ·2CH ₃ COOH	72	2.01	"
24	0.680	"	78	2.22	"
30	0.936	"	84	2.42	"
33	1.06	"	92	2.74	"
36	1.19	"	97	3.05	"
40	1.15	HgCl ₂	106	3.55	"
46	1.30	"	117	4.21	"

Older data by Etard, 1894:

t°	Gms. HgCl ₂ per 100 Gms. Solution	t°	Gms. HgCl ₂ per 100 Gms. Solution	t°	Gms. HgCl ₂ per 100 Gms. Solution
20	2.5	70	8.5	110	13.6
30	3.5	80	9.7	120	16.5
40	4.7	90	11.0	130	20.7
50	6.0	100	12.4	140	25.2
60	7.2			160	34.8

SOLUBILITY OF MERCURIC CHLORIDE IN PYRIDINE (McBride, 1910)

The determinations at the lower temperatures were made by stirring an excess of HgCl₂ with pyridine and analyzing the sat. solution. Those at the higher temperatures were made by the synthetic method.

t°	Gms. HgCl ₂ per 100 Gms. Sat. Sol.	Solid Phase
-32.6	2.76	HgCl ₂ ·2C ₅ H ₅ N
-21.75	7.86	"
0.02	13.14	"
12.58	17.34	"
18.78	19.78	"
27.23	22.65	"
31.05	24.46	"
40.90	29.29	"
50.10	34.94	"
60.03	40.36	"
70.15	46.44	"
76	...	" + HgCl ₂ ·C ₅ H ₅ N
80.02	51.52	HgCl ₂ ·2C ₅ H ₅ N (unstable)
89	56.45	"
94.1	60.09	"
94.7	60.72	HgCl ₂ ·2C ₅ H ₅ N + 3HgCl ₂ ·2C ₅ H ₅ N

(Contd.)

SOLUBILITY OF MERCURIC CHLORIDE IN PYRIDINE--Contd.

t°	Gms. HgCl ₂ per 100 Gms. Sat. Sol.	Solid Phase	
74.7	48.38	HgCl ₂ ·C ₅ H ₅ N	(unstable)
83.5	50.53	"	(stable)
90.4	53.41	"	"
97	56.45	"	"
100.5	57.84	"	"
104.2	60.72	"	"
107	63.06	"	(unstable)
106.2	...	"	3HgCl ₂ ·2C ₅ H ₅ N
95.2	60.77	3HgCl ₂ ·2C ₅ H ₅ N	(unstable)
106.4	61.93	"	(stable)
109.8	62.58	"	"
114	63.18	"	"
124.2	65	"	"
145.5	69.66	"	"

Cl

Data for this system are also given by Staronka (1910).

Data for the solubility of HgCl₂·2C₅H₅N and of Hg(NO₃)₂·2C₅H₅N·2H₂O in aqueous solution of pyridine at 18.1° are given by Stromholm (1908).

SOLUBILITY OF MERCURIC CHLORIDE IN HALOGENATED HYDROCARBONS
(Results of Hoffman, Kirmreuther and Thal, 1910 at 25°)

Solvent	Formula	Gms. HgCl ₂ per 100 Gms. Solvent	Solvent	Formula	Gms. HgCl ₂ per 100 Gms. Solvent
Ethylene Chloride	CH ₂ Cl·CH ₂ Cl	1.229	Dichlorethylene	CHCl·CHCl	0.114
Tetrachlorethane	C ₂ H ₂ Cl ₄	0.090	Trichlorethylene	CHCl·CCl ₂	0.0274
Chloroform	CHCl ₃	0.101	Tetrachlorethylene	CCl ₂ ·CCl ₂	0.0072
Pentachlorethane	C ₂ HCl ₅	0.0193	Carbontetrachloride	CCl ₄	trace

(Results of Sulc, 1900 at 18-20°)

Solvent	Gms. HgCl ₂ per 100 Gms. Solvent
CHBr ₃	0.486
CHCl ₃	0.106
CCl ₄	0.002
C ₂ H ₅ Br	2.010
C ₂ H ₄ Br ₂	1.530

(Results of Dukelski, 1907)
In C₂H₄Cl₂

t°	Gms. HgCl ₂ per 100 gms. Sat. Sol.
0	1.33
12.5	1.55
25.3	1.73
33	2.05
45.9	2.42

(Contd.)

Hg HYDRARGYRUM

Results of Marden and Dover, 1917 at 25° in Mixtures of CHCl_3 + $(\text{C}_2\text{H}_5)_2\text{O}$

Gms. CHCl_3 per 100 Gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent	Gms. CHCl_3 per 100 Gms. Mixture	Gms. HgCl_2 per 100 gms. Mixed Solvent
0	6.95	60	1.48
10	5.85	70	0.95
20	4.73	80	0.657
30	3.70	90	0.328
40	2.80	100	0.128
50	2.10		

C1 SOLUBILITY OF HgCl_2 IN CARBON DISULFIDE (Arctowski, 1894)

t°	Gms. HgCl_2 per 100 Gms. Sat. Sol.	t°	Gms. HgCl_2 per 100 Gms. Sat. Sol.
-10	0.010	20	0.041
0	0.018	25	0.053
10	0.026	30	0.063
15	0.032		

SOLUBILITY OF HgCl_2 IN SEVERAL SOLVENTS

- 100 gms. ethylene diamine dissolve 0.4 gms. HgCl_2 at 25°. (Isbin and Kobe, 1945)
- 100 gms. 95% formic acid dissolve 2.1 gm. HgCl_2 at 19°. (Aschan, 1913)
- 100 gms. 95% formic acid dissolve 0.02 gm. Hg_2Cl_2 at 16.5°. "
- 100 cc anhydrous hydrazine dissolve 1 gm. HgCl_2 with decomp. at room temperature. (Welsh and Broderson, 1915)
- 100 gms. sat. solution of mercuric chloride in selenium oxychloride (SeOCl_2) contain 0.89 gm. HgCl_2 at 25°. (Wise, 1923)
- 100 gms. liquid Sulfur Dioxide dissolve 0.103 gm. HgCl_2 at 0°. (Jander and Ruppolt, 1937)
- 100 gms. anhydrous lanolin (m. pt. about 46°) dissolve 1.55 gms. HgCl_2 at 45°. (Klose, 1907)

FREEZING-POINT DATA ARE GIVEN FOR THE FOLLOWING MIXTURES

Mercuric Chloride + Mercuric Iodide	(Padua and Tibaldi, 1903; Losana, 1926; Bergmann and Gonke, 1926)	
" " + Mercuric Sulfate	(Paic, 1930, 1933)	
" " + Lead Chloride	(Van Driel, 1935)	
" " + Ammonium Chloride	(Belyaev & Mironov, 1902)(Janecke, 1923)	
" " + Sodium chloride	(Belyaev and Mironov, 1952)	
" " + Potassium Chloride	{ " }	
" " + Lithium Chloride	{ " }	
" " + Silver Nitrate	(Bergmann, 1926)	
" " + Thallium Nitrate	{ " }	
" " + Thallium Sulfate	(Waskresenskaja, 1929)	
" " + Selenium	(Olivari, 1909)	Cl
" " + Antimony Chloride	(Kendall, Crittenden and Miller, 1923)	
" " + Sulfur	(Olivari, 1909)	
" " + Nitrobenzene	(Mascarelli, 1906; Mascarelli and Ascoli, 1907)	
" " + <u>o</u> <u>m</u> and <u>p</u> Nitrotoluene	(Mascarelli, 1906, 1907, 1909)	
" " + Urethan	(Mascarelli, 1908, 1909)	
" " + " + Nitronaphthalene	{ " 1906, 1907 }	
" " + " <u>p</u> Nitrotoluene	{ " 1908 }	
" " + " Nitronaphthalene	{ " 1906, 1907 }	
" " + <u>p</u> Nitranisole	{ " 1906 }	

Basic MERCURIC CHLORIDE

SOLUBILITY OF BASIC MERCURIC CHLORIDE IN
HYDROCHLORIC ACID SOLUTIONS AT 25°
(Garrett and Lemley, 1942)

HCl concentrations are initial values. The solid phase was $2\text{HgO} \cdot \text{HgCl}_2$.

Gm. moles per 1000 gms. H_2O		Gm. moles per 1000 gms. H_2O	
HCl	HgO	HCl	HgO
0.0	0.00114	0.01002	0.00878
.00200	.0025	.03003	.0238
.00300	.00325	.0501	.0385
.00500	.0049	.0801	.0626
.00701	.00622	.1008	.0760
.00801	.00684		

MERCURY AMMINE CHLORIDE

Data for the solubility of diammine mercuric chloride, $(\text{NH}_3)_2\text{HgCl}_2 - \text{NH}_2\text{HgCl}$, in aqueous solutions of ammonia at 17.5° are given by Stromholm, (1908).

Hg HYDROXYRUM

Cl ORGANIC MERCURIC CHLORIDES R-HgCl

SOLUBILITIES IN WATER AT 25°
(Okamoto and Nagayama, 1952)

Formula	Moles per liter sat. sol.	Formula	Moles per liter sat. sol.
CH_3HgCl	2.0×10^{-2} *	$\text{C}_4\text{H}_9\text{HgCl}$	1.9×10^{-5}
$\text{C}_2\text{H}_5\text{HgCl}$	1.6×10^{-4}	$\text{C}_6\text{H}_5\text{HgCl}$	2.2×10^{-5}

*Waight, Walton and Laswick, 1955.

MERCURIC Choline CHLORIDE $(\text{CH}_3)_2\text{N}(\text{C}_2\text{H}_5)_2\text{OH} \cdot \text{HgCl}_2$ (Double Salt)

0.4 gms. are dissolved in 100 ml. of solution in water at room temperature: (Seaman, Hugonet, and Leibmann, 1949)

ClO MERCUROUS PERCHLORATE $\text{Hg}_2(\text{ClO}_4)_2$

SOLUBILITY OF MERCUROUS PERCHLORATE IN WATER
(Newbery, 1936)

t°	Gms. $\text{Hg}_2(\text{ClO}_4)_2$ per 100 gms. H_2O	Solid Phase
-20	215	$\text{Hg}_2(\text{ClO}_4)_2 \cdot 4\text{H}_2\text{O}$
0	282	"
+ 8	315	"
17	355	"
20 (d = 2.960)	368	"
30	420	"
35	450	"
36	465	" + $\text{Hg}(\text{ClO}_4)_2 \cdot 2\text{H}_2\text{O}$
37	455	$\text{Hg}(\text{ClO}_4)_2 \cdot 2\text{H}_2\text{O}$
38	455	"
40	457	"
50	480	"
60	500	"
70	516	"
78	536	"
99	580	"

SOLUBILITY OF MERCUROUS PERCHLORATE IN AQUEOUS
SOLUTIONS OF PERCHLORIC ACID AT 21°
(Newbery, 1936)

Mols. free HClO_4 per 100 gms. H_2O	Gms. $\text{Hg}_2(\text{ClO}_4)_2$ per 100 gms. H_2O	Solid Phase
0.10	375	$\text{Hg}_2(\text{ClO}_4)_2 \cdot 4\text{H}_2\text{O}$
0.38	300	"
0.46	280	"
1.27	21.2	$\text{Hg}_2(\text{ClO}_4)_2 \cdot 2\text{H}_2\text{O}$
1.29	13.7	"

(See next page)

The total gm. mols. of HClO_4 in the above solutions is nearly constant hence each added gm. mol. of HClO_4 precipitate approximately one gm. mol. equivalent of the salt.

MERCUROUS CHROMATE Hg_2CrO_4

CrO

The Solubility Product of Mercurous Chromate in Water at 25° is 2.0×10^{-9} as quoted from Immerwahr by Brodsky, 1929.

MERCUROUS FLUORIDE Hg_2F_2

F

SOLUBILITY IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)
[Solid Phase unsolvated]

t°	-22.5	-4.5	+11.8
Gms. Hg_2F_2 per 100 gms. sat. sol.	0.79	0.81	0.877

MERCURIC FLUORIDE HgF_2

SOLUBILITY IN ANHYDROUS HYDROGEN FLUORIDE
(Jache and Cady, 1952)
[Solid phase unsolvated]

t°	-25.2	-7.8	+11.9
Gms. HgF_2 per 100 gms. sat. sol.	0.61	0.62	0.54

MERCUROUS FLUOPHOSPHATE $\text{Hg}_2\text{PO}_3\text{F}$

F

One liter sat. solution of Mercury Fluophosphate in Water contains about 0.0005 gm. mols. ($= 0.025$ gm.) $\text{Hg}_2\text{PO}_3\text{F}$ at 20° . (Lange, 1929)

MERCUROUS IODIDE Hg_2I_2

I

SOLUBILITY OF MERCUROUS IODIDE IN WATER AT 25°
(Sherrill, 1903)

One liter sat. solution contains 2×10^{-7} gms. Hg_2I_2 , determined by indirect method.

Data for the solubility of mercurous iodide in aq. KI solutions at 25° are also given by Sherrill.

(Contd.)

Hg HYDRARGYRUM

The Solubility Product of Mercurous Iodide in Water, calculated from measurements of the E.M.F. of a chain electrode by Brodsky, 1929, is as follows:

t°	Solubility Product
10.8	2.01×10^{-20}
14.9	5.10×10^{-20}
19.2	10.5×10^{-20}
25.0	49.5×10^{-20}
26.5	74.2×10^{-20}

I MERCURIC IODIDE HgI₂

SOLUBILITY OF RED MERCURIC IODIDE IN WATER

t°	Gms. HgI ₂ per liter	Authority
17.5	0.040	(Beurgoin, 1884)
22	0.054	(Rohland, 1898)
25	0.059	(Morse, 1902)
	0.044	(de Bruijn, 1941)(from both under-and super saturation)
	0.0477	(Biederman and Sillen, 1949)

SOLUBILITY OF MERCURIC IODIDE IN WATER AT TEMPERATURES ABOVE 100° DETERMINED BY THE SYNTHETIC METHOD (Benrath, Gjedebø, Schiffers and Wunderlich, 1937)

At 11.5 per cent concentration of HgI₂ and temperature of 241° the mixture separates into two liquid layers, composed of a yellow solution and a wine red melt. These two layers mutually dissolve with rising temperature. At 77 per cent HgI₂ and 338° the solution and melt become identical and mix in all proportions above that temperature.

t°	Gms. HgI ₂ per 100 gms. sat. sol.	Solid Phase	t°	Gms. HgI ₂ per 100 gms. sat. sol.	t°	Gms. HgI ₂ per 100 gms. sat. sol.
196	3.7	HgI ₂	243	12.0	328	54.4
229	9.4	"	257	15.7	336	68.0
241	11.5	"	272	18.7	338	75.0
241	98.0	"	295	27.5	336	82.7
255	100.0	"	314	41.0	322	90.5
			326	49.7	262	97.4

SOLUBILITY OF MERCURIC IODIDE IN MERCURIC NITRATE SOLUTIONS AT 25°
(Yatmirskii, 1951; Yatmirskii and Shutov, 1952)

Moles per 1000 gms. H ₂ O		Moles per 1000 gms. H ₂ O		Moles per 1000 gms. H ₂ O	
Hg(NO ₃) ₂	HgI ₂	Hg(NO ₃) ₂	HgI ₂	Hg(NO ₃) ₂	HgI ₂
0.026	0.0039	0.7210	0.0558	1.4334	0.1480
.090	.0085	.8442	.0684	1.5551	.1538
.1786	.0145	.9979	.0855	1.6404	.1750
.3680	.0275	1.058	.0928	1.7712	.1948
.5440	.0413	1.2123	.1103	1.8587	.2093
.593	.0443	1.3454	.1290		

THE SYSTEM MERCURIC IODIDE - POTASSIUM IODIDE - WATER
(Pernot, 1926, 1927, 1931)

The samples were analyzed by separating the HgI₂ from the KI by sublimation in a glass tube which could subsequently be cut and the amount of each component determined by weighing. The accuracy of the results of Dunningham, 1914, is questioned. No evidence was obtained for the existence of the compound HgI₂·KI which had been found by other investigators. See the tables following for earlier data.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
HgI ₂	KI	Solid Phase	HgI ₂	KI	Solid Phase	HgI ₂	KI	Solid Phase
Results at 0°			Results at 10°			Results at 20°		
19.1	13.3	HgI ₂	19.6	12.0	HgI ₂	10.3	7.4	HgI ₂
32.7	21.1	"	34.9	22.0	"	24.3	16.2	"
39.9	25.0	"	41.7	25.5	"	34.7	21.3	"
41.8	26.7	1.1.1	44.8	27.0	1.1.1	41.3	24.6	"
43.3	29.7	"	46.6	30.7	"	48.2	27.3	" + 1.1.1
45.5	32.1	"	48.1	33.7	"	48.0	29.0	1.1.1
47.8	34.8	"	49.3	35.7	"	48.7	31.3	"
50.2	37.5	"	50.8	37.5	"	49.2	33.4	"
47.5	38.1	KI	50.9	37.9	" + KI	49.9	34.9	"
43.7	38.9	"	48.1	38.3	KI	50.9	36.8	"
39.2	40.0	"	46.5	38.6	"	50.0	37.9	KI
34.0	41.9	"	44.7	39.0	"	45.3	39.1	"
28.4	43.9	"	38.2	41.2	"	31.0	44.4	"
24.1	45.6	"	35.7	42.3	"	16.7	50.6	"
19.3	47.4	"	Results at 56°			8.7	53.8	"
15.6	49.2	"	4.1	3.2	HgI ₂	Results at 80°		
Results at 34°			27.4	16.6	"	1.2	0.6	HgI ₂
3.1	2.2	HgI ₂	46.1	25.0	"	19.1	11.3	"
20.3	12.9	"	57.1	27.5	"	40.8	20.9	"
47.4	26.2	"	57.4	28.8	1.1.1	54.3	24.6	"
53.4	27.7	" + 1.1.1	56.4	30.2	"	65.0	26.2	" + 1.1.1
52.4	29.3	1.1.1	54.9	32.8	"	63.2	27.6	1.1.1
51.9	30.7	"	54.2	37.5	" + KI	61.1	29.4	"
51.7	34.4	"	53.0	37.9	KI	58.2	33.0	"
52.5	37.6	" + KI	46.6	39.8	"	57.5	36.2	" + KI
49.8	38.3	KI	41.2	42.0	"	56.7	36.6	KI
40.1	39.3	"	24.7	49.4	"	46.5	40.4	"
42.3	40.5	"	12.8	56.1	"	28.9	48.3	"
33.7	44.2	"	3.9	61.4	"	15.5	56.2	"
15.6	52.9	"				8.0	60.8	"

1.1.1 = HgI₂·KI·H₂O.

Hg HYDRARGYRUM

Earlier data on the system $\text{HgI}_2 - \text{KI} - \text{H}_2\text{O}$
[See table above for the more recent work.]

(Results of Naude, 1927 at 22.5°)

The solutions were analyzed by reducing the mercury and converting the iodine to KI by adding KOH and $\text{C}_2\text{H}_5\text{OH}$ and warming. The total KI in the filtrate from the Hg was titrated with standard solutions of AgNO_3 and KSCN.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
KI	HgI_2	Solid Phase	KI	HgI_2	Solid Phase	KI	HgI_2	Solid Phase
0.0	0.01	HgI_2	29.18	49.18	1.1.1 $\frac{1}{2}$	34.84	51.53	1.1
1.95	2.02	"	31.18	49.28	"	36.45	51.28	KI
16.16	10.96	"	32.68	49.15	"	36.69	50.01	"
24.60	45.06	"	33.37	49.67	"	37.61	47.04	"
24.57	46.93	"	33.92	40.10	"	40.41	37.41	"
25.10	49.13	" + 1.1.1 $\frac{1}{2}$	33.79	51.13	"	49.60	18.37	"
27.58	49.06	1.1.1 $\frac{1}{2}$	34.04	51.74	1.1	58.33	1.60	"
28.44	48.97	"	34.92	51.58	"	59.20	0.0	"

1.1.1 $\frac{1}{2}$ = $\text{HgI}_2 \cdot \text{KI} \cdot 1\frac{1}{2}\text{H}_2\text{O}$; 1.1 = $\text{HgI}_2 \cdot \text{KI}$.

(Results of Dunningham, 1914)

Results at 20°

Results at 30°

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
KI	HgI_2	Solid Phase	KI	HgI_2	Solid Phase
50.9	19.3	KI	60.6	...	KI
44.4	32.4	"	40.0	53.0	" + KHgI_3
39.0	48.0	"	39.6	52.7	KHgI_3
37.4	53.6	" + KHgI_3	40.0	52.2	"
37.8	52.6	KHgI_3	40.2	51.2	"
35.1	52.2	"	39.3	50.3	"
35.5	51.2	$\text{KHgI}_3 \cdot \text{H}_2\text{O}$	33.7	49.8	"
26.7	50.3	" + HgI_2	33.0	52.0	"
26.6	49.4	HgI_2	31.4	51.7	$\text{KHgI}_3 \cdot \text{H}_2\text{O}$
23.7	40.2	"	29.1	52.2	"
14.9	22.5	"			

(Results of Sherrill, 1903; Herz and Paul, 1913)

Mols. per Liter		Gms. per Liter		Mols. per Liter		Gms. per Liter	
KI	HgI_2	KI	HgI_2	KI	HgI_2	KI	HgI_2
0.05	0.025	8.3	11.4	1.6	0.50	166	227.2
0.10	0.05	16.6	22.7	1.5	0.75	249	340.8
0.20	0.10	33.2	45.4	2.0	1.00	332	454.5
0.50	0.25	83.0	113.6	2.5	1.25	415	578

THE SYSTEM MERCURIC IODIDE - POTASSIUM IODIDE - ETHANOL AT 34°
(Pernot, 1931)

Results using Absolute Alcohol

Results using 95% Alcohol

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
HgI ₂	KI	Solid Phase	HgI ₂	KI	Solid Phase
49.7	14.6	HgI ₂	16.9	4.3	HgI ₂
58.6	18.5	"	41.4	11.6	"
58.8	18.7	" + HgI ₂ ·KI·C ₂ H ₅ OH	54.2	16.7	"
57.0	19.5	HgI ₂ ·KI·C ₂ H ₅ OH	58.2	18.3	" + HgI ₂ ·KI·H ₂ O
54.8	20.9	"	57.0	19.0	HgI ₂ ·KI·H ₂ O
52.7	23.2	"	55.6	20.3	"
51.7	24.8	"	53.0	23.3	"
51.1	25.7	"	51.3	26.9	"
50.1	26.3	KI	50.2	27.0	KI
47.7	25.7	"	20.6	15.3	"
			3.8	6.7	"

THE SYSTEM MERCURIC IODIDE - POTASSIUM IODIDE - ANHYDROUS ACETONE AT 20°
(Pernot, 1926, 1929, 1931)

The author also gives determinations of the equilibrium in acetone containing 2 Vol. % H₂O and 3 Vol. % H₂O, at 20°, 34° and 56°. Great difficulty was experienced in obtaining homogeneous crystals of the double salts. By using different methods of obtaining saturation it was found that in acetone containing 3 Vol. % H₂O the only double salt obtained was HgI₂·KI·H₂O. In acetone containing 2 Vol. % H₂O the double salt 2HgI₂·3KI was obtained only at 56°. The salt HgI₂·2KI was obtained at 56° and at 34° but not at 20°. The only other double salt found was HgI₂·KI.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.		
HgI ₂	KI	Solid Phase	HgI ₂	KI	Solid Phase
37.1	8.4	HgI ₂	65.0	21.0	1.1.1/3-1/4
60.5	13.6	"	64.3	24.4	"
65.8	18.1	"	64.2	21.6	" + KI
66.3	19.6	"	62.9	22.0	KI
66.4	20.4	" + 1.1.1/3-1/4	53.7	22.6	"
65.9	20.5	1.1.1/3-1/4	34.4	20.9	"

1.1.1/3-1/4 = HgI₂·KI·1/3 or 1/4 CH₃COCH₃,

THE SYSTEM MERCURIC IODIDE - POTASSIUM IODIDE - ETHYL ETHER AT 20°
(Dunningham, 1914)

Data are also given for the four component system, HgI₂ + KI + (C₂H₅)₂O + H₂O at 20°. The results are of special interest since 3 liquid layers are formed.

(Contd.)

Hg HYDRARGYRUM

Two liquid layers with compositions as follows, are formed:

Gms. per 100 Gms. Upper Layer		Gms. per 100 Gms. Lower Layer		Solid Phase
KI	HgI ₂	KI	HgI ₂	
1.1	2.8	None		KI + KHgI ₃
1.1	2.4	17.6	53.2	KHgI ₃
0.8	2.5	16.5	56.1	HgI ₂
None		17	58.2	KHgI ₃ + HgI ₃

Data for the distribution of mercuric iodide between aq. KI solutions and benzene at 25° are given by Sherrill, 1903.

Data are also given by Dawson for the distribution of HgI₂ between aqueous solutions of KI and CS₂ at 15° and aqueous solutions of KI and CCl₄ at 18°.

EQUILIBRIUM IN THE SYSTEM MERCURIC IODIDE - RUBIDIUM IODIDE - WATER AT 34° (Pernot, 1940)

The data were given in the form of diagrams only, from which the following values were read.

Gms. RbI per 100 gms. Sat. Sol.	Gms. HgI ₂ per 100 gms. Sat. Sol.	Solid Phase	Gms. RbI per 100 gms. Sat. Sol.	Gms. HgI ₂ per 100 gms. Sat. Sol.	Solid Phase
5.0	4.0	HgI ₂ ·RbI·H ₂ O	44.7	43.7	3:5
10.0	10.7	"	45.5	44.0	3:5 +RbI
20.0	24.3	"	47.0	40.0	RbI
30.0	36.3	"	51.0	30.0	"
40.0	46.0	"	54.7	20.0	"
41.0	47.0	HgI ₂ ·RbI·H ₂ O+3HgI·5RbI	59.0	10.0	"
43.0	44.7	3:5	64.0	0.0	"

SOLUBILITY OF MERCURIC IODIDE IN AQUEOUS IODIDE SOLUTIONS AT 25° (Herz and Paul, 1913)

In Aq. BaI ₂		In Aq. CaI ₂		In Aq. NaI		In Aq. SrI ₂	
Mols. per Liter		Mols. Per Liter		Mols. per Liter		Mols. per Liter	
BaI ₂	HgI ₂	CaI ₂	HgI ₂	NaI	HgI ₂	SrI ₂	HgI ₂
0.099	0.059	0.053	0.050	0.794	0.412	0.254	0.212
0.748	0.742	0.252	0.261	1.385	0.622	0.355	0.320
0.978	0.897	0.468	0.440	2.225	0.945	0.539	0.582
1.508	1.462	1.799	1.760			0.608	0.694

SOLUBILITY OF MERCURIC IODIDE IN ABSOLUTE ALCOHOLS

Alcohol	Formula	t°	Sp. Gr. of Solution	Gms. HgI ₂ per 100 Gms. Alcohol	
Methyl	CH ₃ OH	15-20	0.799	3.24	(Rohland, 1898)
"	"	19	...	3.7	(Timofeiev, 1891)
"	"	19.5	...	3.16	(de Bruyn, 1892)
"	"	23	...	3.98	(Beckmann, 1895)
"	"	66 (b. pt.)	...	6.512	(Sulc, 1900)
Ethyl	C ₂ H ₅ OH	15-20	0.810	1.42	(Rohland, 1898)
"	"	18	...	1.48	(Bourgoin, 1884)
"	"	19	...	1.86	(Timofeiev, 1894)
"	"	19.5	...	2.09	(de Bruyn, 1892)
"	"	25	0.803	2.19	(Herz and Knoch, 1908)
"	"	78 (b. pt.)	...	4.325	(Sulc, 1900)
Propyl	C ₃ H ₇ OH	15-20	0.816	0.826	(Rohland, 1898)
"	"	19	...	1.25	(Timofeiev, 1891)
Amyl	C ₅ H ₁₁ OH	13	...	0.60	(von Laascynski, 1894)
"	"	71	...	3.66	{ " }
"	"	100	...	5.30	{ " }
"	"	133.5	...	9.57	{ " }
Isopropyl	(CH ₃) ₂ CH·OH	81. (b. pt.)	...	2.266	(Sulc, 1900)
Isobutyl	(CH ₃) ₂ CHCH ₂ OH	22.5	...	0.51	(Timofeiev, 1891)
"	"	105-107 (b. pt.)	...	2.433	(Sulc, 1900)

SOLUBILITY OF MERCURIC IODIDE IN MIXTURES OF ABSOLUTE ALCOHOLS AT 25°
(Herz and Kuhn, 1908)

In CH ₃ OH + C ₂ H ₅ OH			In C ₃ H ₇ OH + CH ₃ OH			In C ₃ H ₇ OH + C ₂ H ₅ OH		
Per cent CH ₃ OH in Solvent	d ₂₅ of Sat. Sol.	Gms. HgI ₂ per 100 cc. Sat. Sol.	Per cent C ₃ H ₇ OH in Solvent	d ₂₅ of Sat. Sol.	Gms. HgI ₂ per 100 cc. Sat. Sol.	Per cent C ₃ H ₇ OH in Solvent	d ₂₅ of Sat. Sol.	Gms. HgI ₂ per 100 cc. Sat. Sol.
0	0.8038	1.80	0	0.8156	3.16	0	0.8038	1.80
4.37	0.8039	1.93	11.11	...	...	8.1	0.8036	1.73
10.40	0.8046	2.08	23.80	0.8155	3.04	17.85	0.8043	1.65
41.02	0.8077	2.32	65.20	...	...	56.6	0.8057	1.55
80.69	0.8131	2.89	91.80	0.8101	1.69	88.6	...	...
84.77	0.8140	2.96	93.75	0.8110	1.67	91.2	0.8099	1.52
91.25	0.8146	2.98	96.60	0.8108	1.53	95.2	0.8108	1.44
100	0.8156	3.16	100	0.8116	1.42	100	0.8116	1.42

SOLUBILITY OF MERCURIC IODIDE IN AQUEOUS ALCOHOLS

Aq. Ethyl Alcohol

At 25°

(Herz and Knoch, 1905)

Wt. % Alcohol in Solvent	HgI ₂ per 100 cc Solution		Sp. Gr. of Solutions 25°/4°
	Millimols	Grams	
100	3.86	1.754	0.8033
95.82	2.56	1.162	0.8095
92.44	1.92	0.873	0.8154
86.74	1.38	0.623	0.8300
78.75	0.935	0.425	0.8405
67.63	0.45	0.204	0.8721

(Contd.)

Hg HYDRARGYRUM

Solubility of HgI_2 in Aq. Ethyl Alcohol--Contd.

At 18°
(Bourgoin, 1884)

Solvent	Gms. HgI_2 per Liter
Aba. Alcohol	11.86
$\text{H}_2\text{O} + 80\% \text{ 90° Alc.}$	2.857
$\text{H}_2\text{O} + 10\% \text{ 90° Alc.}$	0.086

At 0°, 25°, 50°
(Reinders, 1900)

95% alcohol, $d_{15} = 0.8126$

0°	0.72 gms. HgI_2 per 100 gms. sat. sol.
25°	1.06 "
50°	2.15 "

Solubility of HgI_2 in Aq. Methyl Alcohol

At 25°

(Herz and Anders, 1907)

Wt. % CH_3OH in Solvent	d_{25}^4 of Solvent	d_{25}^4 of Sat. Sol.	Gms. HgI_2 per 100 cc. Sat. Sol.
47.06	0.9186	00.9187	0.044
64	0.8800	0.8834	0.158
78.05	0.8489	0.8519	0.445
100	0.7879	0.8155	2.590

SOLUBILITY OF MERCURIC IODIDE IN VARIOUS SOLVENTS

(1) Sulc, 1900; (2) Von Laszcynski, 1894; (3) Krug and McElroy, 1892;
(4) Zapata and Zapata, 1930; (5) Beckmann and Stock, 1895; (6) Abegg and
Sherrill, 1903; (7) Naumann, 1910; (8) Reinders, 1900; (9) Herz and
Anders, 1907; (10) Dawson 1910b; (11) Retgers, 1893.

Solvent	t°	Solubility Gms. HgI per 100 gms. solvent	Ref.
Acetone	- 1	2.83	(3)
	18	3.36	(2)
	23	2.04	(5)
	25	2.09	(3)
		2.00 (Red)	(8)
		3.09 (Yellow)	(8)
		3.19	(4)
	40	4.73	(2)
	56 b.pt.	3.249	(1)
	58	6.07	(2)

(Contd.)

SOLUBILITY OF MERCURIC IODIDE IN VARIOUS SOLVENTS--Contd.

Solvent	t°	Solubility Gms. HgI per 100 gms. solvent	Ref.
Benzene	15	0.22	(2)
	23	0.25	(5)
	25	0.224*	(6)
	60	0.88	(2)
	65	0.95	(2)
	80 b. pt.	0.825	(1)
	84	1.24	(2)
	1		
Ethyl acetate	-20	1.49	(2)
	+17.5	1.56	(2)
	18	1.47	(7)
	21	1.64	(2)
	40	2.53	(2)
	55	3.19	(2)
	76	4.31	(2)
	74-78 (b. pt.)	4.20	(1)
Aqueous Ethyl Acetate		(at 25°, Ref. 9)	
	Wt. % CH ₃ ·COOC ₂ H ₅ in Solvent	d ₂₅ of Sat. Sol.	Gms. HgI ₂ per 100 cc. Sat. Sol.
	4.36	0.9973	0.013
	96.74	0.9063	1.87
	100	0.9011	1.09
Chloroform	18-20	0.040	(1)
	23	0.07	(5)
	61 (b. pt.)	0.163	(1)
Bromoform	18-20	0.486	(1)
Carbon tetrachloride	18-20	0.006	(1)
	18	0.0170*	(10)
	75 (b. pt.)	0.094	(1)
Ethyl Bromide	18-20	0.643	(1)
	38° (b. pt.)	0.773	(1)
Ethylene Dibromide	18-20	0.748	(1)
Ethyl Iodide	18-20	2.041	(1)
Ethylene Dichloride	85-5° (b. pt.)	1.200	(1)
Iso-Butyl Chloride	69 "	0.328	(1)
Methyl Formate	36-38 "	1.166	(1)
Ethyl Formate	52-55 "	2.150	(1)
Methyl Acetate	56-59 "	2.500	(1)
Acetal	105 "	2.000	(1)
Epichlorhydrin	117 "	6.113	(1)
Hexane	67 ...	0.072	(1)
Methylene Iodide	15	2.5	(11)
	100	16.6	(11)
	180	58.0	(11)
Ethyl ether	0	0.62	(2)
	35 b. pt.	0.47	(1)
	36	0.97	(2)

Data for the extraction of HgI₂ from 6.9N HCl by ethyl ether is practically "complete." (Kitahara, 1948). Data are given by Dawson, 1909b for the partition of HgI₂ between aqueous KI solution and CCl₄ at 18°.

*Gms. per 100 cc sat. sol.

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC IODIDE IN ANILINE (Pearce and Fry, 1914)

Additional data on this system are also given by Staronka, 1910.

Gms. HgI ₂ per 100 Gms.			Gms. HgI ₂ per 100 Gms.		
t°	Aniline	Solid Phase	t°	Aniline	Solid Phase
-11.48*	...	C ₆ H ₅ NH ₂ +HgI ₂ ·2C ₆ H ₅ NH ₂	48.8	128.1	HgI ₂ (red)
- 6.5	23.35	HgI ₂ ·2C ₆ H ₅ NH ₂	63.6	163.8	"
+ 0.4	28.69	"	70.82	184.1	"
17.8	42.85	"	76.2	201.6	"
21.1	47.55	"	95.9	246.7	"
26.9	55.47	"	108†	...	" + HgI ₂ (yellow)
30.1	62.05	"	115.7	281.8	HgI ₂ (yellow)
36.2	75.80	"	137.2	285.2	"
42.9	96.49	"	181.1	297.9	"
46.8†	...	" + HgI ₂ (red)	199.1	863.2	"

*Eutec.

†Tr. pt.

SOLUBILITY OF MERCURIC IODIDE IN PYRIDINE

(Determinations from -50° to 98.5° made by saturating the solvent at constant temperatures are given by Mathews and Ritter (1917). Measurements of the points of solidification of various mixtures of the two components, covering the range from 10° to 135°, are given by Staronka (1910).

Gms. HgI ₂ per 100 Gms.			Gms. HgI ₂ per 100 Gms.		
t°	Sat. Sol.	Solid Phase	t°	Sat. Sol.	Solid Phase
-50	1.93	HgI ₂ ·2C ₅ H ₅ N	90.08	61.43	HgI ₂ ·2C ₅ H ₅ N
-31.5	4.27	"	100	65.72	"
-10	10.28	"	105	68.89	"
- 0.1	14.85	"	107 m. pt.	72.09	"
+ 8.83	18.42	"	105	76.67	"
20.02	24.40	"	100	79.73	"
25.55	27.90	"	90	84.16	"
40.08	37.64	"	87 Eutec.	85.17	" + HgI ₂ ·C ₅ H ₅ N
50.02	43.15	"	100	86	HgI ₂ ·C ₅ H ₅ N
60.07	48.29	"	120	87.16	"
80.05	57.60	"	135	88.78	"

SOLUBILITY OF MERCURIC IODIDE IN QUINOLINE (Staronka, 1910)

Mols. HgI ₂ per 100 Mols.			Mols. HgI ₂ per 100 Mols.		
t°	HgI ₂ +C ₉ H ₇ N	Solid Phase	t°	HgI ₂ +C ₉ H ₇ N	Solid Phase
100	4.7	HgI ₂ ·2C ₉ H ₇ N	160	37.7	HgI ₂ ·C ₉ H ₇ N
115.5	9.1	"	165	41.6	"
133.5	13.2	"	165	43	"
138	23.1	"	170	48.8	"
145	26.7	HgI ₂ ·C ₉ H ₇ N	169.5	49.5	"
153	31.4	"	166.5	54.4	"

SOLUBILITY OF MERCURIC IODIDE IN NITROBENZENE AND p-NITROTOLUENE

Data for the solubility of mercuric iodide in nitrobenzene and in p nitrotoluene, determined by the synthetic (sealed tube method), are given by Smits and Bakhorst (1915). The transition point of HgI_2 , red to yellow, was found to be at 1.68 mol. per cent HgI_2 and 127.5° in nitrobenzene and 1.81 mol. per cent HgI_2 and 128° in p nitrotoluene. The interesting part of the investigation is the characteristic prolongation of the melting line above the transition point. Similar data for the solubility of mercuric iodide in nitrobenzene, m nitrotoluene, p nitrotoluene and in nitronaphthalene, determined by the freezing-point method, using a Beckmann apparatus, are given by Mascarelli (1906a). Observations on the appearance and color changes of the HgI_2 are given.

SOLUBILITY OF MERCURIC IODIDE IN CARBON DISULFIDE
(Linebarger, 1894; Arctowski, 1894, 1895-96)

t°	Gms. HgI_2 per 100 Gms. Solution	t°	Gms. HgI_2 per 100 Gms. Solution	t°	Gms. HgI_2 per 100 Gms. Solution
-116	0.017	- 5	0.141	15	0.271*
- 93	0.023	0	0.173	20	0.320
- 86.5	0.024	+ 5	0.207	25	0.382
- 10	0.107	10	0.239	30	0.445

*One liter sat. solution of mercuric iodide in CS_2 contains 3.127 gms. at 15° . (Dawson, 1909b).

Data are given by Dawson, 1909b for the partition of HgI_2 between aqueous KI solutions and CS_2 at 15° .

SOLUBILITY OF MERCURIC IODIDE IN ANHYDROUS ACETIC ACID
DETERMINED BY THE SYNTHETIC METHOD
(Davidson and Chappell, 1938)

t°	Mols. HgI_2 per 100 mols. $HgI_2 + CH_3COOH$	Solid Phase	t°	Mols. HgI_2 per 100 mols. $HgI_2 + CH_3COOH$	Solid Phase
31	0.011	HgI_2	76	0.065	HgI_2
47	0.021	"	90	0.097	"
56	0.030	"	100	0.134	"
67	0.045	"	110	0.192	"

Hg HYDRARGYRUM

SOLUBILITY OF MERCURIC IODIDE IN METHYLAL ($\text{HCH}(\text{OCH}_3)_2$) (Bourgoin, 1924)

The methylal was purified by distillation over sodium. At the lower temperatures the solutions were saturated by constant agitation. At the higher temperatures the synthetic method was used.

t°	Gms. HgI_2 per 100 gms. sat. sol.	Solid Phase	t°	Gms. HgI_2 per 100 gms. sat. sol.	Solid Phase
20	3.81	HgI_2 (red)	74	5.80	HgI_2 (red)
25	4.07	"	77	5.93	"
30	4.19	"	81	6.05	"
53	4.56	"	123	7.89	"
63	5.12	"	125 (tr. pt.)	7.96	" + HgI_2 (yellow)
67	5.32	"	136.5	8.00	HgI_2 (yellow)
71	5.56	"	166	8.14	"

SOLUBILITY OF MERCURIC IODIDE IN OILS (Data of Anon, 1903, 1904)

Oil	Gms. HgI_2 per 100 cc Oil	Oil	Gms. HgI_2 per 100 cc Oil
Castor Oil	1.90	Peanut Oil	0.52
Walnut "	1.29	Olive "	0.45
Linseed "	1.23	Almond "	0.39
Cod Liver Oil	0.545	Vaseline	0.26

(Data of Mehu, 1885)

Solvent	t°	Gms. HgI_2 per 100 gms. Solvent	Solvent	t°	Gms. HgI_2 per 100 gms. Solvent
Bitter Almond Oil*	25	0.5	Vaseline	25	0.025
Bitter Almond Oil	100	1.3	Vaseline	100	0.20
Castor Oil	25	4.0	Poppy Oil	25	1.0
Castor Oil	100	20.0	Olive Oil	25	0.4
Nut Oil	100	1.3	Carbolic Acid	100	2.0

*100 Grams oil of bitter almonds dissolve 5.0 grams $\text{HgI}_2 \cdot \text{KI}$ at 25° . (Mehu)

SOLUBILITY OF HgI_2 IN LIQUID SO_2 AND H_2NNH_2

100 gms. liquid Sulfur Dioxide dissolve 0.012 gm. HgI_2 at 0° . (Jander and Ruppolt, 1937)

100 cc anhydrous hydrazine dissolve 69 gms. HgI_2 with precipitation of Hg at room temp. (Welsh and Broderson, 1915)

Fusion-point data are given for the following mixtures.

HgI ₂ + AgNO ₃	(Bergmann, 1921, 1922-4, 1926)
" + HgSO ₄	(Paic, 1930, 1933)
" + I	(Olivari, 1908)
" + TiNO ₃	(Bergmann, 1926)
" + TiSO ₄	(Woskresenskaja, 1929)
" + NaI	(Belyaev and Mironov, 1952a)
" + NH ₄ I	{ " }
" + KI	{ " } (Belyaev, 1953)

MERCURIC AMMONIUM IODIDE HgI₂·2NH₄I·H₂O

100 gms. sat. sol. of Mercuric Ammonium Iodide in Water contain 22.6 gms. Hg, 4.5 gms. NH₄ and 62.3 gms. I at 26°; d of sat. sol. = 2.98. (Duboin, 1905)

MERCURIC DIAMMINE IODIDE Hg(NH₃)₂I₂

Data for the solubility of diammine mercuric iodide in aqueous ammonia solutions at 20° are given by Francois (1900). The solid is not stable in solutions containing less than 48 gms. NH₃ per liter.

METHYL MERCURIC IODIDE CH₃HgI

At 25°, a saturated solution in water contains 0.0010 moles per liter. (Waught, Walton and Laswick, 1955)

MERCUROUS IODATE Hg₂(IO₃)₂

The Solubility Product of Mercurous Iodate in Water at 25° is 1.3 x 10⁻¹⁸ as quoted from Spencer, 1912, by Brodsky, 1929.

At 25°, 6.0 x 10⁻⁷ gms. HgIO₃ are dissolved in one liter of saturated aqueous solution. (Kryukova, 1939).

MERCUROUS NITRATES xHg₂O·yN₂O₅·zH₂O

EQUILIBRIUM IN THE SYSTEM, MERCUROUS OXIDE, NITROGEN PENTOXIDE AND WATER AT 25° (Denham and Fife, 1933)

In the case of the normal salt, mixtures of the required amounts of HNO₃, H₂O and finely ground mercurous nitrate were shaken in sealed bottles until equilibrium was reached. For the preparation of the basic salts either mercurous nitrate was shaken with the necessary amount of

Hg HYDRARGYRUM

water or mercurous oxide was shaken with HNO_3 . The mercury in the saturated solutions was determined by electrolysis and the nitrate by a modification of the Devarda method.

d. of sat. solution	Gms. per 100 gms. sat. sol.		Solid Phase	d. of sat. solution	Gms. per 100 gms. sat. sol.		Solid Phase
	Hg ₂ O	N ₂ O ₅			Hg ₂ O	N ₂ O ₅	
1.039	3.03	1.00	A	1.557	31.00	12.10	α D
1.058	4.64	1.40	"	1.447	26.88	12.27	"
1.082	6.55	2.30	"	1.396	22.30	12.87	"
1.095	7.57	2.44	"	1.382	21.21	13.30	"
1.113	8.66	3.01	"	1.359	19.25	14.00	" + β D
1.117	9.12	3.22	" + B	1.366	19.63	14.53*	α D
1.139	10.46	3.61	B	1.455	22.97	15.84*	"
1.200	15.10	5.44	"	1.464	23.30	16.20*	"
1.275	18.42	6.60	"	1.563	27.65	17.20*	"
1.328	21.10	7.70	"	1.638	30.80	18.00*	"
1.366	23.53	8.22	"	1.781	34.88	19.35*	"
1.450	27.28	9.61	"	1.485	26.38	13.29*	β D
1.502	29.31	10.43	" + C	1.442	24.22	13.55*	"
1.510	29.70	10.50	C	1.405	22.12	13.82*	"
1.527	30.18	10.75	"	1.365	19.84	13.87*	"
1.565	31.76	11.20	"	1.359	19.25	14.00	"
1.608	33.00	11.79	" + D	1.426	20.66	17.70	"

* = Metastable

A = $2\text{Hg}_2\text{O} \cdot \text{N}_2\text{O}_5 \cdot \text{H}_2\text{O}$; B = $5\text{Hg}_2\text{O} \cdot 3\text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$; C = $4\text{Hg}_2\text{O} \cdot 3\text{N}_2\text{O}_5 \cdot \text{H}_2\text{O}$;

D = $\text{Hg}_2(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$ which exists in an α and a β form.

100 cc. anhydrous hydrazine dissolve about 2 gms. $\text{Hg}_2(\text{NO}_3)_2$ with precipitation of Hg at room temp. (Welsh and Broderon, 1915)

NO MERCURIC NITRATE $\text{Hg}(\text{NO}_3)_2$

At 19° one liter of a solution in ethyl ether, saturated with $\text{Hg}(\text{NO}_3)_2 \cdot 8\text{H}_2\text{O}$ contains 0.06 gms. $\text{Hg}(\text{NO}_3)_2$. (Bachelet, Cheylan and Le Bris, 1950).

100 gms. anhydrous lanolin (m. pt. about 46°) dissolve 1.15 gm. $\text{Hg}(\text{NO}_3)_2$ at 45°. (Klose, 1907)

NO. ALKYL and ARYL MERCURIC NITRATES RHgNO_3

SOLUBILITY OF EACH SEPARATELY IN WATER AT 25°
(Johns, Peterson and Hixon, 1930)

Compound	Formula	Gm. Mols. Compound per liter sat. sol.
Ethyl Mercuric Nitrate	$\text{C}_2\text{H}_5\text{HgNO}_3$	0.0239
Butyl " "	$\text{C}_4\text{H}_9\text{HgNO}_3$	0.003
Benzyl " "	$\text{C}_6\text{H}_5\text{CH}_2\text{HgNO}_3$	0.00263
o Xylyl " "	$\text{C}_6\text{H}_4(\text{CH}_3)_2\text{HgNO}_3$	0.00057
Phenyl " "	$\text{C}_6\text{H}_5\text{HgNO}_3$	0.00236

MERCUROUS HYDROXIDE HgOH

OH

One liter of a saturated solution in water at 25° contains 5.2×10^{-9} gms. HgOH. (Kryukova, 1939)

Oka, 1940 found the solubility of mercurous hydroxide in water to be 4.2×10^{-7} moles per liter.

The Solubility Product of Mercurous Oxide in Water at 25° is 1.8×10^{-24} as quoted from Burgarsky, 1897, by Brodsky, 1929.

MERCURIC OXIDE HgO
MERCURIC HYDROXIDE HgOH

O
OH

SOLUBILITY IN WATER

t°	Gms. HgO per liter		Author
	Yellow HgO	Red HgO	
18	0.052	0.0515	Ragg, 1950
25	0.0518	0.0513	Schick, 1903
-	-	0.05 (large grains)	Hulett, 1901
-	-	0.15 (finest grains)	
-	0.0513	0.0487	Garrett and Hirschler, 1938
-	-	0.0544	Herz and Hiebenthal, 1928
100	0.410	0.379	Schick, 1903

SOLUBILITY OF YELLOW AND OF RED MERCURIC OXIDE IN
AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°
(Garrett and Howell, 1939)

Values for HNO₃ are those of the solutions as made up. The solutions were maintained in an atmosphere of nitrogen. Calculations of the acidity corrected for the amount of acid used to react with the oxide are given.

Results for Yellow Mercuric Oxide

Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O	
HNO ₃ x 10 ⁻⁴	HgO x 10 ⁻²	HNO ₃ x 10 ⁻⁴	HgO x 10 ⁻²	HNO ₃ x 10 ⁻⁴	HgO x 10 ⁻²
0.5	2.43	156	58.5	700	312
1.0	2.57	200	65.5	703	312
2.0	2.67	200	68.0	722	329
4.0	3.11	300	111.0	743	333
6.0	3.35	300	108.0	761	349
8.0	3.80	400	173.0	780	362
10.3	4.15	400	169.0	976	449
20.0	6.08	500	217.0	1170	536
40.0	12.1	585	236.0	1370	638
60.0	18.3	600	253.0	1400	596
80.0	23.2	634	262.0	1560	718
106.0	30.0	683	299.0	1600	662

(Contd.)

Results for Red HgO

Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O	
HNO ₃ x 10 ⁻⁴	HgO x 10 ⁻⁴	HNO ₃ x 10 ⁻⁴	HgO x 10 ⁻⁴
1.0	2.98	20.0	6.32
2.0	3.14	30.0	9.17
3.0	2.77	50.0	14.2
5.0	3.48	70.0	20.2
7.0	3.56	90.0	27.9
9.0	4.02	200.0	64.2

0 SOLUBILITY OF YELLOW MERCURIC OXIDE IN HYDROCHLORIC ACID SOLUTIONS AT 25°
(Garrett and Lemley, 1942)

The authors found that the compound 2HgO·HgCl₂ formed in solutions containing over 0.007 moles HCl/1000 gms. of H₂O. From 0.007 M to 0.08 M the solubility is nearly constant (two phases?), and above this concentration of HCl the solubility increases rapidly (solid phase 2HgO·HgCl₂). Since the yellow HgO changed to black 2HgO·HgCl₂, the phase change could be roughly followed by the color changes. Two sets of data are presented which agree fairly well up to 0.08 M in HCl, but which differ from each other by a nearly constant 0.05 moles/1000 gms. H₂O at higher concentrations of HCl. The authors' data were plotted, and the following values read from the average curves. In the range above 0.08 M HCl the higher set of values are given since they are identical with the solubility of 2HgO·HgCl₂ when the HCl needed to form the compound is subtracted from the total amount present.

Gm. moles per 1000 gms. H ₂ O		Probable Solid Phase
HCl (initial)	HgO	
0.001	0.0008	HgO (Yellow)
.002	.0013	"
.003	.0017	"
.004	.0022	"
.005	.0027	"
.006	.0031	"
.007	.0036	"
.008	.0041	"
.009	.0047	"
.010	.0052	"
.007-0.09	0.0019	" + 2HgO·HgCl ₂ (Black)
.100	.0082	2HgO·HgCl ₂ (Black)
.121	.0237	"
.141	.0387	"
.161	.0545	"
.202	.0880	"
.243	.1150	"
.283	.1410	"

Data for the amount of HCl remaining in solution after reaction is also given.

SOLUBILITY OF MERCURIC OXIDE IN AQUEOUS HYDROFLUORIC ACID AT 25°
(Jaeger, 1901)

Normality of HF	Gm. Hg per 9.6 cc. Sat. Sol.	Gm. Atoms Hg per Liter
0.12	0.0242	0.01258
0.24	0.0475	0.0247
0.57	0.1210	0.0629
1.11	0.2247	0.1168
2.17	0.4976	0.2586

SOLUBILITY OF MERCURIC OXIDE IN ACETIC ACID SOLUTIONS CONTAINING
SODIUM ACETATE AT 35°
(Mahapatra, Aditya, and Prasad, 1953)

Moles per liter			Moles per liter		
Initial NaC ₂ H ₃ O ₂	Initial HC ₂ H ₃ O ₂	Total Hg dissolved	Initial NaC ₂ H ₃ O ₂	Initial HC ₂ H ₃ O ₂	Total Hg dissolved
0.50	0.50	0.1864	0.10	0.20	0.0674
.25	.25	.0800	.625	.125	.03757
.125	.125	.03757	.05	.10	.0277
.10	.10	.0283	.04	.08	.0192
.0625	.0625	.01636	.02	.04	.0084
.05	.05	.01227	.01	.02	.0034
.04	.04	.0089	.10	1.00	.0287
.0625	.25	.0690	.50	0.05	.0098
.05	.20	.0663	.25	.025	.00296
.04	.16	.0488	.04	.32	.1081
.02	.08	.0200	.02	.16	.0481
.010	.04	.0083	.01	.08	.0198
1.00	0.5	0.2054	.0625	.03125	.00628
0.50	.25	.08095	.05	.0250	.005095
.25	.125	.0357	.50	.100	.0266
.125	.0625	.0162	.25	.05	.01104
.100	.050	.00968	.125	.025	.005065
			.10	.020	.003863

SOLUBILITY OF YELLOW AND OF RED MERCURIC OXIDE IN
AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE AT 25°
(Garrett and Hirschler, 1938)

The determinations were made in an atmosphere of nitrogen. Equilibrium was approached both from under saturation and super saturation. The alkali was determined by titration, using methyl orange as indicator. The mercury was determined by a potentiometric method.

(Contd.)

Hg HYDRARGYRUM

Results for Yellow HgO

Results for Red HgO

Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O		Gm. Mols. per 1000 gms. H ₂ O	
NaOH	HgO	NaOH	HgO	NaOH	HgO	NaOH	HgO
0.00010	0.000234	0.3467	0.000249	0.00088	0.000225	0.7223	0.000251
0.00082	0.000238	0.5995	0.000255	0.0050	0.000225	1.001	0.000262
0.0018	0.000232	0.8515	0.000265	0.0093	0.000226	1.638	0.000272
0.0040	0.000237	1.512	0.000282	0.0187	0.000224	1.987	0.000276
0.0100	0.000237	2.562	0.000296	0.1064	0.000227	2.940	0.000294
0.0207	0.000237	3.405	0.000306	0.3398	0.000231	3.956	0.000297
0.1015	0.000244	4.460	0.000312	0.4406	0.000242	4.936	0.000298
0.2230	0.000241	5.952	0.000311	0.5818	0.000246		

Somewhat similar data by Fuaeya, 1920:

(The authors' original data should be divided by 100).

Millimoles per
liter sat. sol.

NaOH	0.0	9.6	50.3	95.5	502.	1075.8	2000.
HgO	0.234	.246	.247	.249	.266	.283	.309

One liter of 49.8% NaOH (18.8 N) at 142° (boiling point) dissolves 2.1 gms. HgO. (Garrett and Lemley, 1942)

SOLUBILITY OF YELLOW MERCURIC OXIDE IN AQUEOUS ALKALIES AND ALKALINE SALT SOLUTIONS AT 25° (Garrett and Hirschler, 1938)

Gm. Mols. per 1000 gms. H ₂ O			Gm. Mols. per 1000 gms. H ₂ O		
Alkali	+ Salt	HgO	Alkali	+ Salt	HgO
0.1082 KOH	--	0.000240	0.1328 NaOH	2.400 KNO ₃	0.000384
0.3038 "	--	0.000243	0.1462 "	1.072 NaNO ₃	0.000326
0.8175 "	--	0.000253	0.1738 "	2.637 "	0.000496
0.0689 LiOH	--	0.000239	0.1682 "	6.397 "	0.000753
0.2019 "	--	0.000246	0.1433 "	0.5863 Na ₂ SO ₄	0.000301
0.4667 "	--	0.000252	0.1380 "	1.145 "	0.000347
0.1361 NaOH	0.8143 KNO ₃	0.000291	0.1649 "	1.668 "	0.000370
0.1789 "	1.725 "	0.000337	0.1454 "	2.137 "	0.000390

SOLUBILITY OF MERCURIC OXIDE IN AQUEOUS SALT SOLUTIONS AT 25° (Herz and Hiebethal, 1928)

Results for aqueous:

Potassium Chloride Gm. Equivalents per liter		Lithium Chloride Gm. Equivalents per liter		Sodium Chloride Gm. Equivalents per liter	
KCl	HgO	LiCl	HgO	NaCl	HgO
0.35	0.0008	0.35	0.0008	1.05	0.0026
0.70	0.0011	0.51	0.0011	1.55	0.0036
0.85	0.0013	0.74	0.0014	2.12	0.0046
1.49	0.0023	0.99	0.0020	3.13	0.0074
2.35	0.0038	2.15	0.0053	4.22	0.0091
3.13	0.0054	2.47	0.0061	5.45	0.0158

Ferry and Riley (1946), calculate that 0.08 gms. HgO dissolve in 1 cc. of sea water of pH = 8.1 at 25°.

Ragg (1950) found 0.288 gms. yellow HgO or 0.219 gms. red HgO will dissolve in a liter of Baltic sea water at 18°.

PHENYL MERCURIC HYDROXIDE $\text{HgC}_6\text{H}_5(\text{OH})$

OK

SOLUBILITY IN SODIUM HYDROXIDE SOLUTIONS AT 0° (Schramm, 1947)

Normality of NaOH	Gms. $\text{HgC}_6\text{H}_5(\text{OH})$ per 100 cc.
0.0	0.52
.0185	.48
1	.36

At 25°, Okamoto and Nagayama (1952) report a solubility of 1.1×10^{-4} moles per liter.

MERCUROUS Meta PHOSPHATE HgPO_3

PO

One liter of a saturated solution in water contains 3.5×10^{-7} gms. HgPO_3 at 25°. (Kryukova, 1939).

MERCUROUS SULFIDE Hg_2S

S

One liter of a saturated solution in water at 25° contains 2.8×10^{-23} gms. Hg_2S . (Kryukova, 1939)

The Ksp is reported as 9×10^{-52} by Goates, Cole and Gray (1951), and 3×10^{-52} by Goates, Gorden and Faux (1952).

MERCURIC SULFIDE HgS

S

SOLUBILITY IN WATER AND PERCHLORIC ACID SOLUTION

Treadwell and Schaufelberger (1946) calculate the thermodynamic solubility product to be 0.3×10^{-51} . A 1 N solution of HClO_4 which is saturated with H_2S dissolves 3.3×10^{-7} moles of HgS per liter at 18°.

One liter H_2O dissolves 0.054×10^{-4} mols. $\text{HgS} = 0.0000125$ gm. at 18°. (Weigel, 1906, 1907. See also Bruner and Zawadzki)

Hg HYDRARGYRUM

THE SOLUBILITY OF MERCURIC SULFIDE IN SODIUM SULFIDE SOLUTIONS AT 25° (Dickson and Tunell, 1954)

Results with Red HgS

Gms. per 100 gms. sat. sol.

Na ₂ S	HgS
0.95	0.21
1.50	0.57
2.31	1.34
3.58	2.91
4.37	4.12
6.07	7.29
9.64	15.59

Results with Black HgS (metastable)

Gms. per 100 gms. sat. sol.

Na ₂ S	HgS
0.51	0.11
1.37	0.79
2.85	2.76
6.55	10.24
10.93	20.70

SO MERCUROUS SULFITE Hg₂SO₃

One liter of a saturated solution in water at 25° contains 1.5×10^{-11} gms. Hg₂SO₃. (Kryukova, 1939)

SO MERCUROUS SULFATE Hg₂SO₄

SOLUBILITY IN WATER AND VERY DILUTE SULFURIC ACID SOLUTIONS

[Upon treatment with water, Hg₂SO₄ is gradually converted to the very insoluble basic salt Hg₂SO₄·Hg₂O·H₂O.]

Results at 25°

Solvent	Hg ₂ SO ₄ per Liter	
	Gm. Mol.	Gms.
Water	...	0.35 (1)
"	...	0.47 (2)
"	...	0.39 (3)
"	11.7×10^{-4}	0.58 (4)
Aq. H ₂ SO ₄ :		
(1.96 gms. per liter)	8.31×10^{-4}	0.41 (4)
(4.90 gms. per liter)	8.78 "	0.44 (4)
(9.80 gms. per liter)	8.04 "	0.40 (4)

(1) Quoted from Bugarsky, 1897, by Brodsky, 1929.

(2) Wright and Thomson, 1884-85.

(3) Wilsmore, 1900.

(4) Drucker, 1901.

(Contd.)

Solubility of Hg_2SO_4 in dil. H_2SO_4 at Various Temperatures
(Barre, 1911)

t°	Gms. per 100 Gms. Sat. Sol.	
	Hg_2SO_4	H_2SO_4
16.5	0.055	0.008
33	0.060	0.018
50	0.065	0.037
75	0.074	0.063
100	0.092	0.071

Freezing-point data for mixtures of $\text{Hg}_2\text{SO}_4 + \text{H}_2\text{SO}_4$ are given by Kendall and Davidson, 1921.

30

SOLUBILITY OF MERCUROUS SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID
AT 0° AND AT 28°
(Craig, Vinal and Vinal, 1936)

Equilibrium was approached both from above and below. Mercury was determined electrolytically and the H_2SO_4 in the electrolyzed solution was titrated. The acid equivalent to the Hg was subtracted from the total to obtain the H_2SO_4 in the original solution. The results were plotted and the following average values obtained from the curve. The data agree very closely with those of Hulett, 1904 at 25°.

Gm. Mols. H_2SO_4 per 1000 cc solution	Gm. Hg per 100 cc sat. sol. at:		Gm. Mols. H_2SO_4 per 1000 cc solution	Gm. Hg per 100 cc sat. sol. at:	
	0°	28°		0°	28°
0.001	0.0351	-	0.100	0.0183	0.0344
0.002	0.290	0.0463	0.200	0.0198	0.0379
0.004	0.0239	0.0395	0.40	0.0224	0.0423
0.006	0.0215	0.0360	0.60	0.0239	0.0451
0.008	0.0203	0.0346	0.80	0.0247	0.0467
0.010	0.0197	0.0338	1.00	0.0249	0.0470
0.020	0.0182	0.0318	1.50	0.0240	0.0452
0.040	0.0178	0.0317	2.00	0.0216	0.0409
0.060	0.0178	0.0327	3.00	0.0139	0.0294
0.080	0.0180	0.0337	4.00	0.0078	-

SOLUBILITY OF MERCUROUS SULFATE IN AQUEOUS POTASSIUM SULFATE SOLUTIONS
(Barre, 1911)

Results at 15°			Results at 33°		
Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
K_2SO_4	Hg_2SO_4	H_2SO_4 (free)	K_2SO_4	Hg_2SO_4	H_2SO_4 (free)
2.90	0.0475	0.0080	2.94	0.0677	0.0250
5.70	0.0703	0.0093	5.68	0.1015	0.0350
8.22	0.0912	0.0098	8.30	0.1364	0.0441
8.77	0.0994	...	10.70	0.1724	0.0438
9.44	0.1080	0.0110	11.90	0.1902	0.0420

(Contd.)

Hg HYDRARGYRUM

Results at 75°

Gms. per 100 Gms. Sat. Sol.

K_2SO_4	Hg_2SO_4	H_2SO_4 (free)
3.10	0.1344	0.1684
5.75	0.2120	0.2135
8.50	0.2051	0.2514
13.20	0.4610	0.2503
17.30	0.6440	0.2225

At 25°, 0.45 gms. Hg_2SO_4 dissolve in a liter of solution containing 9.05 gms. K_2SO_4 . (Drucker, 1901)

SOLUBILITY IN LIQUID SULFUR DIOXIDE

100 gms. liquid Sulfur Dioxide dissolve 0.010 gm. Hg_2SO_4 at 0°. (Jander and Ruppolt, 1937)

SO MERCURIC SULFATE $HgSO_4$

EQUILIBRIUM IN THE SYSTEM, MERCURIC OXIDE, SULFUR TRIOXIDE, WATER
(Hoitsema, 1895)

Results expressed in molecules per sum of 100 molecules of the three components of the system. The mixtures were rotated for 3 hours or longer.

Results at 25°

Results at 50°

Liquid Phase			Solid Phase	Liquid Phase			Solid Phase
H_2O	SO_3	HgO		H_2O	SO_3	HgO	
98.5	1.24	0.33	$3HgO \cdot SO_3$	98.9	0.96	0.17	$3HgO \cdot SO_3$
96.6	2.49	0.92	"	96.0	3.05	0.93	"
94.4	3.93	1.65	"	93.2	4.92	1.90	"
93.9	4.24	1.85	$3HgO \cdot SO_3$ and	92.8	5.10	2.09	"
94.4	4.52	2.12	$3HgO \cdot 2SO_3 \cdot 2H_2O$	92.8	5.16	2.06	"
93.4	4.65	1.94	$3HgO \cdot 2SO_3 \cdot 2H_2O$	92.5	5.34	2.12	"
92.9*	4.81	2.29	$3HgO \cdot SO_3$	92.2	5.57	2.20	{ $3HgO \cdot SO_3$ and $3HgO \cdot 2SO_3 \cdot 2H_2O$
92.9	5.11	1.98	$3HgO \cdot 2SO_3 \cdot 2H_2O$	92.1	5.75	2.11	
92.3*	5.20	2.54	$3HgO \cdot SO_3$	92.1	5.75	2.11	$3HgO \cdot 2SO_3 \cdot 2H_2O$
92.3	5.58	2.09	$3HgO \cdot 2SO_3 \cdot 2H_2O$	92.0	5.80	2.16	"
92.1	5.81	2.08	"	91.2*	6.27	2.56	{ $3HgO \cdot SO_3$ and $HgO \cdot SO_3$
91.9	5.97	2.90	$3HgO \cdot SO_3$	91.5	6.34	2.19	
91.9	6.15	2.05	$3HgO \cdot 2SO_3 \cdot 2H_2O$	91.5	6.34	2.19	{ $3HgO \cdot 2SO_3 \cdot 2H_2O$ and $HgO \cdot SO_3$
91.3	6.54	2.13	"	91.3*	6.37	2.30	
91.2	6.77	2.02	$HgO \cdot SO_3 \cdot H_2O$	91.6	6.69	1.77	"
91.3	6.90	1.80	"	91.1	8.32	0.57	"
91.3	7.67	1.01	"	90.5	9.11	0.4	"
91.3	7.84	0.89	$HgO \cdot SO_3 \cdot H_2O$ and	89.6	10.2	0.23	"
91.0	8.36	0.69	$HgO \cdot SO_3$	86.7	13.2	0.06	"
90.5	8.95	0.53	"	31.6	68.4	0.03	"
89.2	10.6	0.22	$HgO \cdot SO_3$				
75.8	24.2	trace	"				
39.2	60.7	trace	"				

*Indicates unstable equilibrium.

BASIC MERCURIC SULFATE $\text{HgSO}_4 \cdot 2\text{HgO}$ S₀SOLUBILITY OF BASIC MERCURIC SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25-30°
(Vosburgh and Lackey, 1930)

The mercury was determined by titration with standard thiocyanate solution.

Gm. Mols. H_2SO_4 per liter	Gm. Mols. per liter	
	HgO	SO_3
0.01194	0.00103	0.01228
0.0954	0.0131	0.0998
0.1450	0.0203	0.1518

MERCUROUS THIOSULFATE $\text{Hg}_2\text{S}_2\text{O}_3$ S₀

One liter of a saturated solution in water at 25° contains 2.2×10^{-15} gms. $\text{Hg}_2\text{S}_2\text{O}_3$. (Kryukova, 1939)

MERCURIC SELENITE HgSeO_3 Se₀SOLUBILITY IN AQUEOUS SODIUM SELENITE SOLUTIONS AT 25°
(Rosenheim and Pritze, 1909)

Normality of Na_2SeO_3 Solution	Gms. HgSeO_2 per 100 gms. Sat. Sol.	Normality of Na_2SeO_3 Solution	Gms. HgSeO_2 per 100 gms. Sat. Sol.
0.0625	0.18	0.5	0.70
0.125	0.32	1	1.39
0.25	0.53	2	2.73

MERCUROUS METAVANADATE HgVO_3

VO

MERCURIC METAVANADATE $\text{Hg}(\text{VO}_3)_2$ SOLUBILITY PRODUCTS IN WATER AT 18°
(Zolotavin, 1947)

HgVO_3 :	2.6×10^{-8}	$\text{Hg}(\text{VO}_3)_2$:	10^{-12}
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HOLMIUM Ho

HOLMIUM SULFATE $\text{Ho}_2(\text{SO}_4)_3$ S₀

SOLUBILITY IN WATER

t°	Gms. $\text{Ho}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ per 100 gms. H_2O	Solid Phase	Author
20	8.181	$\text{Ho}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$	(Jackson and Reinacker, 1939)
25	6.705	"	(Spedding and Jaffe, 1954)
40	4.52	"	(Jackson and Reinacker, 1930)

IODINE

IODINE

SOLUBILITY OF IODINE IN WATER

The results of Sammet, 1905; Carter, 1925, 1928; Hartley, 1908; Lanza, 1931, and Kracek, 1931, were plotted on cross section paper and the following values read from the average curve. At 25°, the average solubility found by eight additional investigators is 0.001331±.000006 moles per liter (= .338 ± .001 gms. per liter).

Lanza found that supersaturation occurs easily, especially at the higher temperatures, and such solutions give up their iodine very slowly.

t°	Gms. I per liter sat. sol.	t°	Gms. I per liter sat. sol.	t°	Gms. I per liter sat. sol.
0	0.14	30	0.385	80	2.25
10	0.20	40	0.52	90	3.15
20	0.285	50	0.71	100	4.45
25	0.336	60	1.00	106	5.60
		70	1.50	112.3	7.20*

*Invariant Point, two liquid layers formed.

Results in Water above 112°

By means of determinations made in sealed tubes by the synthetic method, Kracek (1931) found that above 112.3° two liquid layers are formed. The critical solution temperature, estimated to be above 300°, could not be reached because of the extremely high vapor pressure developed by the system. The following points on the curve for the liquid layers were determined.

Aqueous Layer		Liquid Iodine Layer	
t°	Gms. I per 100 gms. liquid layer	t°	Gms. I per 100 gms. liquid layer
126.5	0.976	112.3	99.907*
143.2	1.422	155	99.712
156.4	1.947	186	99.530
175.9	3.082	> 225	99.083
188.4	4.125		
206.7	6.587		

SOLUBILITY OF IODINE IN HYDRIODIC ACID SOLUTIONS AT 25°

Results in Dilute Solutions

(Carter and Hoskins, 1929)				(Oliveri-Mandala and Angenica, 1920) (25.2°)			
Mols. per 1000 Mols. H ₂ O		Mols. per 1000 Mols. H ₂ O		moles per liter		moles per liter	
HI	I ₂	HI	I ₂	HI	I ₂	HI	I ₂
0.2117	0.1326	1.321	0.7908	0.0604	0.0295	0.3120	0.1633
0.5284	0.2956	1.763	0.9228	0.0922	0.0459	0.4230	0.2358
0.8810	0.4715	4.964	2.784	0.1209	0.0610	0.5000	0.3000
				0.2110	0.1117	0.6350	0.3950

(Contd.)

SOLUBILITY OF IODINE IN HYDRIODIC ACID SOLUTIONS AT 25°—Cont.

Results in Concentrated Solutions
(Powell and Campbell, 1947)

Highly purified reagents were used, and sampling was done in an atmosphere of helium. The authors estimate their accuracy as 1%.

Original Solvent		Saturated Solution			Kg. I ₂ per liter of Solvent	Kg. I ₂ per 1000 gms. of Solvent
% HI	d ₄ ²⁵	% HI	% I ₂	d ₄ ²⁵		
66.7	1.946	18.1	72.85	3.28	5.22	2.68
64.0	1.877	18.2	71.55	3.22	4.72	2.52
54.4	1.644	17.5	67.8	..	3.47	2.11
50.2	1.557	17.8	64.6	..	2.84	1.825
45.9	1.486	18.1	60.5	..	2.28	1.532

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF HYDROBROMIC ACID

(Data of Lee and Lee, 1936)

(Data of
Oliveri-Mandala
and Angenica,
1920 at 25°)
Gms. mols.
per liter

Gm. Mols. HBr per liter sat. sol.	Gm. Mols. I ₂ per liter sat. solution at:					
	15°	25°	35°	45°	HBr	I ₂
0.05	0.00167	0.00221	0.00281	0.00302	0.500	0.0081
0.100	0.00241	0.00319	0.00400	0.00533	0.635	0.0096
0.588	0.00849	0.01048	0.01348	0.01766	1.2433	0.0203
1.209	0.01678	0.02109	0.02690	0.03511	1.8649	0.0328
1.851	0.02720	0.03284	0.04165	0.04878	2.7973	0.0514
3.182	0.04241	0.05192	0.06478	0.08354	3.7297	0.0750

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

At 25°
(Carter and Hoskins, 1929)
moles per 1000
gms. H₂O

At 25.4°
(Oliveri-Mandala and Angenica, 1920)
Gm. mols.
per liter

HCl		HCl		HCl		HCl	
I ₂		I ₂		I ₂		I ₂	
8.48	0.0431	65.3	0.170	0.001	0.001332*	2.0539	0.00430
17.9	0.0655	79.5	0.197	0.500	0.00170	2.5530	0.00511
25.1	0.0793	109.2	0.252	1.1230	0.00256	2.3139	0.00640
31.5	0.0951	141.0	0.299	1.5540	0.00320	3.8550	0.00730
				1.8010	0.00373		

*Bray and MacKay, 1910.

Results for the solubility of iodine in aq. HCl solutions at 25°, which do not agree with the above, are given by Ray and Sarkar, 1922.

The solubility of iodine in aqueous HCl solutions at 25°, 35°, and 45° is reported by Lee and Chen, 1937.

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF NITRIC ACID
(Carter, 1925)

Results at 10°		Results at 25°		Results at 35°	
Wt.	Gm.	Wt.	Gm.	Wt.	Gm.
per cent HNO ₃	mols. I ₂ per liter	per cent HNO ₃	mols. I ₂ per liter	per cent HNO ₃	mols. I ₂ per liter
11.80	0.000969	10.91	0.00160	3.31	0.00187
23.88	0.001035	23.16	0.00179	6.50	0.00204
32.35	0.001020	33.62	0.00186	15.50	0.00233
40.82	0.000985	42.28	0.00185	28.72	0.00260
49.57	0.000957	52.77	0.00189	42.63	0.00275
55.82	0.000962	63.81	0.00236	43.13	0.00273
64.30	0.00108	69.65	0.00312	58.37	0.00368
70.00	0.00178	72.60	0.00394		

One liter of saturated solution in 0.10 N HCl contains 0.001340 moles I₂. (Sammet, 1905).

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°
(Carter, 1925; Bower and Scott, 1953)

The results are in good agreement. Most of the data of Bower and Scott are given only in graphical form. The solubility increases rapidly above 87% H₂SO₄.

Wt.	Gm.		Wt.	Gm.	
per cent H ₂ SO ₄	mols. I ₂ per liter	Color of solution	per cent H ₂ SO ₄	mols. I ₂ per liter	Color of solution
11.87	0.00102	Brown	72.04	0.000270	Pink
22.72	0.00082	"	86.5	0.000207*	
33.25	0.000615	"	87.37	0.000200	
40.42	0.000545	" + Pinkish	90.0	0.000339*†	
59.53	0.000380	Pinkish + brown	94.9	0.000423*	

*Bower and Scott
†estimated from graph.

0.001342 moles I₂ are dissolved in a liter of saturated solution in 0.10 N H₂SO₄. (Sammet, 1905).

SOLUBILITY OF IODINE IN PERCHLORIC ACID SOLUTIONS
(Katzin and Gebert, 1955)

Solvent	Moles I ₂ per liter sat. sol.		
	20°	25°	30°
H ₂ O	0.001127	0.001320	0.001526
0.01 M HClO ₄	.001129	.001310	.001520
1.0 M HClO ₄	.001053	.00127	.001465
0.01 M HClO ₄ + 0.09 M NaClO ₄	.001093	.001269	.00136
0.01 M HClO ₄ + 0.99 M NaClO ₄	...	.000965	...
0.1 M NaClO ₄	.001126	.001275	.00146
1.0 M NaClO ₄	.001834	.001039	.00115

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF BARIUM IODIDE AT 25°
(Pearce and Eversole, 1924)

Gm. mols. per 1000 gms. H ₂ O		Gm. mols. per 1000 gms. H ₂ O	
BaI ₂	I ₂	BaI ₂	I ₂
0.0000	0.001329	0.16497	0.16872
0.000686	0.002044	0.34880	0.39500
0.003120	0.004482	0.39633	0.45460
0.006287	0.007574	0.57189	0.81690
0.031674	0.032199	0.87640	1.4674
0.047716	0.048413	1.1922	2.2880
0.080477	0.079370		

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF CADMIUM IODIDE AT 25°
(Van Name and Brown, 1917)

Grams CdI ₂ per liter	3.66	45.78	91.56	183.12
" I ₂ " "	2.072	9.056	11.386	14.040

THE SYSTEM IODINE - POTASSIUM IODIDE - WATER AT 25°

There has been some dispute on the nature of the solid phases in contact with solutions containing less than 10% H₂O. Parsons and Whittemore (1911) rotated mixtures for 6 months or longer, and made duplicate determinations at different lengths of time, but failed to find any solid polyiodides.

A review of the evidence for and against the existence of potassium tri iodide was given by Bancroft, Söhner and Gould, 1931. The authors verified one of the results (analysis No. 8) of Parsons and Whittemore, 1911, of which there appeared some doubt. This was done by adding and excess of either iodine, potassium iodide or so-called potassium tri iodide to a synthetically prepared solution corresponding to the quadruple point of the system. No change in the composition of the solution occurred. From this and other evidence it was concluded that potassium tri iodide does not exist at 25°.

Footo and Chalker, 1908 and Grace, 1931 both report finding the salts KI₃ and KI₇. In Grace's work the mixtures were initially heated to about 50° and then rotated at 25° for one month. Both the sat. solution and moist solid phases were analyzed. The diagram and the analyses confirmed the existence of the two polyiodides KI₃.H₂O and KI₇.H₂O.

Additional data are given by Bruner (1898), Hamberger (1906), and Landi (1908).

(Results of Parsons and Whittemore, 1911)

Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	KI	I			KI	I	
1.349	16.03	18.49	Iodine	3.246	27.92	66.45	KI
1.516	19.70	26.16	"	3.232	29.71	62.81	"
1.769	22.88	36.06	"	2.665	35.80	49.61	"
1.910	23.55	40.52	"	2.539	38.09	44.58	"

(Contd.)

(Contd.)

IODINE

THE SYSTEM IODINE - POTASSIUM IODIDE - WATER AT 25°--Cont.

(Results of Parsons and Whittimore, 1911)--Cont.

Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	KI	I			KI	I	
2.403	24.78	53.60	Iodine	2.216	44.82	31.01	KI
2.904	25.00	63.12	"	2.066	49.04	23.08	"
3.082	25.18	66.04	"	1.888	54.41	11.63	"
3.316	26.00	68.09	" + KI	1.733	60.39	0.0	"

(Results of Grace, 1931)

The author also gives several experiments upon equilibrium in the non aqueous solvents, tetrachlor ethane and benzene.

Gms. per 100 gms. sat. solution			Solid Phase	Gms. per 100 gms. sat. solution			Solid Phase
I ₂	KI	H ₂ O		I ₂	KI	H ₂ O	
57.83	32.18	9.96	KI	66.65	27.04	6.38	KI ₇ .H ₂ O
61.97	30.25	7.83	" + KI ₃ .H ₂ O	67.34	26.52	6.20	"
63.40	29.09	7.45	KI ₃ .H ₂ O	68.02	26.00	6.00	" + I
63.88	28.92	7.16	"	65.98	25.08	..	I
64.85	28.36	6.87	"				
66.10	27.26	6.59	" + KI ₇ .H ₂ O				

(Results of Foote and Chalker, 1908)

Gms. per 100 gms. sat. sol.		Solid Phase	Gms. per 100 gms. sat. sol.		Solid Phase
KI	I		KI	I	
29.45	64.34	KI + KI ₃	25.88	68.79	KI ₇ + I ₂
28.91	63.88	"	25.57	69.01	"
26.84	66.54	KI ₃ + KI ₇	27.86	66.56	KI ₃
27.18	67.14	"	27.27	66.91	"
27.14	66.60	"	26.95	57.17	KI ₇
			25.71	67.91	"

SOLUBILITY OF IODINE IN POTASSIUM IODIDE SOLUTIONS

Results in Very Dilute Solutions
(Determinations made with very great care)

Results at 0°			Results at 25°		Results at 25°	
(Jones and Hartman, 1915)			(Bray and MacKay, 1910)		(Noyes and Seidenstricker, 1898)	
Normality of Aq. KI Sol.	d ₄ ²⁵ of sat. Sol.	Gms. I per 100 Gms. Sat. Sol.	Normality of Aq. KI Sol.	Millimols I ₂ per liter Sat. Sol.	Normality of Aq. KI Sol.	Millimols I ₂ per liter Sat. Sol.
0.000992	1.0002	0.0282	0.0	1.333	0.0	1.342
0.00200	1.0004	0.0409	0.001	1.788	0.00083	1.814
0.00500	1.0010	0.0760	0.002	2.266	0.00166	2.235
0.01000	1.0020	0.1356	0.005	3.728	0.00664	4.667
0.01988	1.0044	0.2533	0.010	6.185	0.01329	8.003
0.0500	1.0109	0.609	0.020	11.13	0.03657	14.68
0.09993	1.0219	1.199	0.050	25.77	0.05315	28.03
			0.100	51.35	0.1063	55.28

Results at Higher Concentrations at 25°
(Reichstein, Ewentow and Kasarnowsky, 1933)

The mixtures were rotated constantly for 200 hours. The saturated solutions were analyzed by diluting an unweighed portion of the filtered solution with water and distilling the free iodine into KI solutions. This was titrated with thiosulfate and the fixed iodine remaining in the distilling flask titrated with silver nitrate according to Volhard. The densities of the saturated solutions were measured in a 1.5 cc pycnometer.

The authors also give results in the form of a diagram showing the effect of additions of sugar upon the ratio of I₂/KI at different KI concentrations. The presence of sugar increases the solubility of I at low concentrations of KI and diminishes it at high concentrations.

d ₄ ²⁵ of sat. sol.	Gm. Mols. KI per liter	Ratio $\frac{I}{KI}$	d ₄ ²⁵ of sat. sol.	Gm. Mols. KI per liter	Ratio $\frac{I}{KI}$
1.008	0.055	0.96	1.776	2.870	2.09
1.025	0.136	1.00	1.889	3.281	2.23
1.055	0.273	1.08	1.900	3.315	2.25
1.095	0.541	1.15	2.006	3.647	2.34
1.255	1.052	1.39	2.090	4.024	2.45
1.335	1.330	1.50	2.200	4.376	2.56
1.390	1.551	1.59	2.289	4.710	2.69
1.508	1.985	1.74	2.357	5.030	2.82
1.512	2.001	1.75	2.390	5.160	2.83
1.652	2.448	1.91	2.504	5.630	2.98
1.760	2.809	2.07	2.640	6.259	3.17

Data of Linhart, 1918 at 25°

Mols. KI per 1000 gms. H ₂ O	0.4136	0.5954	0.8065	1.0246
Mols. I ₂ "	0.2313	0.3538	0.5176	0.7079

I IODINE

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF MIXTURES CONTAINING POTASSIUM IODIDE AT 25° (LaMer and Lewinsohn, 1934)

Gm. Mols. Salts per liter	Gm. Mols. I ₂ per liter
0.0 (= H ₂ O at pH 5.0)	0.001321
2.0 KNO ₃ + 0.0025 KI	0.002138
1.65 KCl + 0.10 KI	0.004421

Results are also given for a number of other mixtures of salts.

SOLUBILITY OF IODINE IN AQUEOUS SODIUM IODIDE SOLUTIONS (Gill, 1913-14)

Aqueous NaI solutions were prepared by dissolving the stated amounts of the salt in water and diluting to 100 cc. An excess of iodine was added to each of these solutions, the mixtures heated to 60° and shaken for several minutes. They were then allowed to cool in a thermostat at 25° for four hours. The dissolved iodine in weighed amounts of the saturated solutions was titrated with thiosulfate. The densities of the Aq. NaI mixtures and also of the solutions after saturation with iodine were determined.

Gms. NaI per 100 cc. Aq. Solution	d ₂₅ of Aq. NaI Solution	d ₂₅ of Aq. NaI after Saturation with I	Gms. I Dissolved at 25° per 100 Gms. of the Sat. Sol.
5	1.0369	1.0698	4.99
10	1.0720	1.1415	9.96
15	1.1072	1.2162	14.93
20	1.1458	1.2998	20.02

Determinations at other temperatures were made in an apparatus which permitted constant stirring of the solutions at the several temperatures. Results, interpolated from the original, are as follows:

Gms. I Dissolved per 100 Gms. Sat. Solution in Aq. NaI of:			Gms. I Dissolved per 100 Gms. Sat. Solution in Aq. NaI of:		
t°	10 Gms. per 100 cc.	20 Gms. per 100 cc.	t°	10 Gms. per 100 cc.	20 Gms. per 100 cc.
10	8.9	17.6	30	10.3	20.5
15	9.3	18.3	40	10.9	22
20	9.6	19	50	11.7	23.4
25	10	19.4	60	12.6	24.9

SOLUBILITY OF IODINE IN AQUEOUS SODIUM IODIDE ALONE
AND CONTAINING SODIUM SULFATE AT 25°
(Carter, 1928)

Results for:

Aq. NaI Solutions		Aq. NaI + Na ₂ SO ₄ Solutions		
Gm. Mols. per 1000 gms. H ₂ O		Gm. Mole. per 1000 gms. H ₂ O		Gm. Mols. I ₂ per 1000 gms. H ₂ O
NaI	I ₂	NaI	Na ₂ SO ₄	
0.0	0.001324	0.000251	1.698	0.000413
0.000392	0.001494	0.000655	"	0.000497
0.000784	0.001676	0.001431	"	0.000666
0.001959	0.002260	0.003271	"	0.001048
0.003918	0.003199	0.006531	"	0.001738
0.007838	0.005126	0.01274	"	0.003063
0.01959	0.01096	0.02619	"	0.006031
		0.05253	"	0.1190

The authors also give results for the solubility of iodine at 25° in aqueous solutions of NaBr + Na₂SO₄, NaI + NaNO₃ and NaI + Na₂SO₄.

Additional data on the system I₂ - NaI - H₂O, with reference to the formulation of iodine solutions for pharmaceutical use, are given by Goldstein (1952).

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS AT 25°
(Herz and Hiebenthal, 1929; Carter and Hoakins, 1929; Carter, 1925;
Bell and Buckley, 1912; Herz and Paul, 1914; McLaughlin, 1903)

<u>Potassium Chloride</u> (H. & B.)		<u>Magnesium Chloride</u> (H. & H.)		<u>Barium Chloride</u> (H. & H.)	
Gm. Mols. per liter sat. solution		Gm. Mols. per liter sat. solution		Gm. Mols. per liter sat. solution	
KCl	I ₂	1/2 MgCl ₂	I ₂	1/2 BaCl ₂	I ₂
0.20	0.00276	0.39	0.00339	0.23	0.00278
0.34	0.00292	0.59	0.00419	0.52	0.00388
0.64	0.00389	1.49	0.00620	0.83	0.00453
1.93	0.00670	3.00	0.00764	1.59	0.00571
2.75	0.00800	4.55	0.00718	2.70	0.00675
4.85	0.00756	9.72	0.00148	3.35	0.00675
(C. & H.)		(C. & H.)		(C. & H.)	
Gm. Mols. per 1000 gm. Mols. H ₂ O		Gm. Mols. per 1000 gm. Mols. H ₂ O		Gm. Mols. per 1000 gm. Mols. H ₂ O	
KCl	I ₂	1/2 MgCl ₂	I ₂	1/2 BaCl ₂	I ₂
6.15	0.0349	8.48	0.0394	3.67	0.0305
12.3	0.0438	13.0	0.0465	4.89	0.0318
24.6	0.0589	26.3	0.0634	12.1	0.0426
36.3	0.0711	53.5	0.0741	24.0	0.0538
48.2	0.0822	67.5	0.0750	35.6	0.0610
60.6	0.0905	96.1	0.0732	46.9	0.0660
73.9	0.0975	125.9	0.0636	57.8	0.0676
86.8	0.1003	141.3	0.0573	68.6	0.0671
(Cont.)		(Cont.)		(Cont.)	

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS AT 25°--Cont.
(Hers and Hiebenthal, 1929; Carter and Hoekina, 1929; Carter, 1925;
Bell and Buckley, 1912; Hers and Paul, 1914; McLauchlin, 1903)--Cont.

<u>Potassium Chloride</u> (K. & U.) Moles I ₂ per liter in			<u>Magnesium Chloride</u> (K. & U.) Moles I ₂ per liter in			<u>Barium Chloride</u> (K. & U.) Moles I ₂ per liter in		
Molarity of KCl	H ₂ O	0.025 N KI	Molarity of MgCl ₂	H ₂ O	0.025 N KI	Molarity of BaCl ₂	H ₂ O	0.025 N KI
0.0	0.001332	0.01362	0.6882	0.002492	0.01314	0.5	0.002226	0.01286
0.5	0.002206	0.01342	1.72	0.003595	0.01240	1.5	0.003035	0.00941
1.0	0.002821	0.01308	3.441	0.003959	0.01023	3.0	0.003550	0.00665
	0.00259*	...	5.162	0.003752	0.00774			
1.5	0.003315	0.01271	6.882	0.002999	0.00565			
2.0	0.003753	0.01250						
3.0	0.004476	0.01231						
4.0	0.004890	0.01219						

*(M.)

<u>Sodium Sulfate</u> (C.) Wt. Gm. mols. I ₂ per cent per 1000 gma. Na ₂ SO ₄ mols. H ₂ O at 25°			<u>Sodium Chloride</u> (H. & H.) Gm. Mols. per liter sat. solution NaCl I ₂		<u>Sodium Nitrate</u> (C.) Wt. Gm. mols. I ₂ per cent per 1000 gm. NaNO ₃ mols. H ₂ O at 25°	
5.66	0.173		0.20	0.00274	5.89	0.0222
8.64	0.0144		0.44	0.00344	11.10	0.0202
16.24	0.00855		1.23	0.00511	15.31	0.0185
19.66	0.00656		2.39	0.00612	25.67	0.0145
			3.45	0.00613	29.75	0.0125
			5.34	0.00534	35.43	0.0108
1.05	0.0318				39.83	0.00911
4.93	0.0252			(C.)	44.16	0.00753
9.13	0.0202		4.52	0.04403		
14.79	0.0133		7.43	0.05295		
21.10	0.00839		14.14	0.06289	1.98	0.0327
25.31	0.00585		20.31	0.06311	3.48	0.0320
33.10	0.00258		23.15	0.05105	6.85	0.0302
			25.95	0.05790	15.89	0.0268
					29.06	0.0201
					40.17	0.0143
					50.1	0.0100

K. & U. (at 25°) Moles I ₂ per liter in			(K. & U.) Moles I ₂ per liter in			(K. & U.) Moles I ₂ per liter in		
Molarity of Na ₂ SO ₄	H ₂ O	0.025 N KI	Molarity of NaCl	H ₂ O	0.025 N KI	Molarity of NaNO ₃	H ₂ O	0.025 N KI
0.21	0.00113*	...	0.5	0.002083	0.01306	0.5	0.001238	0.01280
0.25	0.001210	0.01283	1.0	0.00227*	...	1.0	0.001012*	...
0.75	0.001052	0.01139	1.5	0.002960	0.01196	1.5	0.001048	0.01146
2.0	0.000705	0.00837	3.0	0.003320	0.00987	3.0	0.000780	0.00798
3.5	0.000440	0.00526	5.0	0.002942	0.00707	5.0	0.000573	0.00567
						7.5	0.000369	0.00370

*(M.)

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF VARIOUS SALTS AT 25°--Cont.

(Herz and Hiebenthal, 1929; Carter and Hoskins, 1929; Carter, 1925; Bell and Buckley, 1912; Herz and Paul, 1914; McLauchlin, 1903)--Cont.

Strontium Chloride

(H. & H.)

Gm. Mols. per liter
sat. solution1/2 SrCl_2 I_2

0.46	0.00371
0.86	0.00468
1.46	0.00571
2.37	0.00665
4.50	0.00637
6.16	0.00489

Potassium Bromide

(B. & B.)

Gms. KBr
per literGm. Atoms I
per liter

60.6	0.0176
106.9	0.0278
175.9	0.0415
229.8	0.0532
281.9	0.0628
330.6	0.0717
377.1	0.0797
411	0.0864
461.7	0.0948
509.8	0.1006
567.9 sat.	0.1094

Sodium Bromide

(B. & B.)

Gms. NaBr
per literGm. Atoms I
per liter

96.4	0.0266
187.7	0.0425
271.8	0.0538
357.4	0.0598
422.21	0.0638
499.1	0.0648
569.9	0.0644
632	0.0622
679.7	0.0595
750.5	0.0551
756.1 sat.	0.0550

Lithium Chloride

(H. & H.)

Gm. Mols. per
liter sat.
solutionLiCl I_2

0.46	0.00379
0.96	0.00503
1.98	0.00679
3.90	0.00746
6.43	0.00596
12.08	0.00127

MercuricChloride

(H. & P.)

Gms. per liter

 HgCl_2 I

0	0.340
25.64	3.285
33.78	3.706
54.29	4.583
90.84	6.454

Sodium Dihydrogen Phosphate

(C.)

Wt.
per cent
 $\text{NaH}_2(\text{PO}_4)_2$ Gm. mols. I_2
per 1000 gms.
mols. H_2O

7.53	0.0194
14.40	0.0161
20.64	0.0135
26.4	0.0111
31.66	0.00893
41.06	0.0043
45.26	0.0018

SOLUBILITY OF IODINE IN SOLUTIONS OF VARIOUS OTHER SALTS IN WATER AND IN SOLUTIONS OF 0.025 NORMAL POTASSIUM IODIDE AT 25°

(v. Kiss and Urmeneczy, 1931)

Gm. Mole. Salt per liter	Gm. Mols. I_2 per liter in:		Gm. Mole. Salt per liter	Gm. Mols. I_2 per liter in:	
	H_2O Solution	0.025 n KI Solution		H_2O Solution	0.025 n KI Solution
0.5 LiNO_3	0.001270	0.01292	0.5 Li_2SO_4	0.001127	0.01224
1.5 "	0.001187	0.01202	1.5 "	0.000798	0.01015
3.5 "	0.001038	0.01045	3.0 "	0.000474	0.00692
5.5 "	0.000856	0.00886	5.0 "	0.000238	0.00386
8.7 "	0.000564	0.00586	0.6855 $\text{Hg}(\text{NO}_3)_2$	0.001230	0.1303
0.25 K_2SO_4	0.000939*	...	1.714 "	0.001053	0.01193
0.5 "	0.001190	0.01246	3.427 "	0.000891	0.01045
1.0 "	0.001034	0.01126	5.135 "	0.000674	0.00874
1.37 "	0.000909	0.01052	6.855 "	0.000530	0.00717

*McLauchlin, 1903

(Cont.)

SOLUBILITY OF IODINE IN SOLUTIONS OF VARIOUS OTHER SALTS IN WATER AND IN SOLUTIONS OF 0.025 NORMAL POTASSIUM IODIDE AT 25 --Cont.

Gm. Mols. Salt per liter	Gm. Mols. I ₂ per liter in:		Gm. Mols. Salt per liter	Gm. Mols. I ₂ per liter in:	
	H ₂ O Solution	0.025 n KI Solution		H ₂ O Solution	0.025 n KI Solution
0.5 LiCl	0.002330	0.01351	0.5 MgSO ₄	0.001174	0.01239
1.5 "	0.003246	0.01270	3.0 "	0.000600	0.00742
3.5 "	0.003876	0.00971	5.0 "	0.000351	0.00396
6.0 "	0.003275	0.00655	0.5264 Ca(NO ₃) ₂	0.001229	0.01314
9.0 "	0.002012	0.00349	1.316 "	0.001097	0.01234
13.0 "	0.000301	0.00136	2.632 "	0.000910	0.01104
0.6714 CaCl ₂	0.002505	0.01338	3.948 "	0.000736	0.00967
1.676 "	0.003675	0.01265	5.264 "	0.000615	0.00854
3.35 "	0.004382	0.01080	0.5 KNO ₃	0.001257	0.01305
5.025 "	0.003811	0.00869	1.0 "	0.001161	0.01277
6.714 "	0.003136	0.00671	"	0.001049*	...
0.25 Ba(NO ₃) ₂	0.001300	0.01286	2.0 "	0.001041	0.01215
0.50 "	0.001243	0.01249	3.0 "	0.000902	0.01178

*McLauchlan, 1903

Data of McLauchlan, 1903 for several other salts:

Salt	Gms.		Salt	Gms.	
	Gms. Salt per liter	Dissolved I per liter		Gms. Salt per liter	Dissolved I per liter
NH ₄ Cl	53.4	0.735	(NH ₄) ₂ SO ₄	33	0.246
NaBr	103	3.29	NH ₄ NO ₃	80	0.375
KBr	119	3.801	(NH ₄) ₂ C ₂ O ₄	86.9	0.980
NH ₄ Br	98	4.003	H ₃ BO ₃	55.8	0.300
NH ₄ C ₂ H ₃ O ₂	77.1	0.440			

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL

Results at 15°
(Schoorl and Regenbogen, 1919)

Due to the ready formation of HI, accurate determinations of the solubility of iodine in aqueous alcohol can be made best by diluting a solution of iodine in absolute alcohol with water, and determining immediately the C₂H₅OH and iodine content of the resulting solution. At concentrations of alcohol less than 18 per cent the addition of water does not precipitate iodine from its saturated solution. The maximum precipitation of iodine occurs when just enough water is added to bring the alcohol concentration to 18 per cent.

The determinations were plotted and the following values read from the curve.

Wt. per cent C ₂ H ₅ OH in aq.-alc. solvent	Gms. I per 100 gms. solvent	Wt. per cent C ₂ H ₅ OH in aq.-alc. solvent	Gms. I per 100 gms. solvent	Wt. per cent C ₂ H ₅ OH in aq.-alc. solvent	Gms. I per 100 gms. solvent
0.0	0.025	35.0	0.35	70.0	4.3
5.0	0.033	40.0	0.55	75.0	5.6
10.0	0.045	45.0	0.80	80.0	7.2
15.0	0.06	50.0	1.20	85.0	9.0
20.0	0.08	55.0	1.70	90.0	11.4
25.0	0.11	60.0	2.30	95.0	14.2
30.0	0.20	65.0	3.20	100.0	20.0

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL--Cont.

Data of Bruner, 1898 at 15°

Vol. % C ₂ H ₅ OH in Solvent	Gms. I per 100 cc. Solution	Vol. % C ₂ H ₅ OH in Solvent	Gms. I per 100 cc. Solution
10	0.05	60	1.14
20	0.06	70	2.33
30	0.10	80	4.20
40	0.26	90	7.47
50	0.88	100	15.67

Data of Delepine and
Arquet, 1928 at 15°

Wt. Per cent C ₂ H ₅ OH in Solvent	Gms. I per 100 gms. sat. Solution
85	6.50
90	8.50
95	12.5
99.8	18.7

Results at 25°

Data of McLauchlan, 1903

[Recalculated because the
original value for the solu-
bility in H₂O was too low.]

Gms. C ₂ H ₅ OH per 100 Gms. Solvent	Gms. I per 100 cc. Sat. Solution
0	0.034
4.55	0.039
28.48	0.172
44.41	0.955
72.51	6.698
100	24.548

Data of Delepine and Arquet,
1928 (24.5°)

Wt. Per cent C ₂ H ₅ OH in Solvent	Gms. I per 100 gms. sat. Solution
85	7.97
90	10.2
95	14.8
99.8	21.0

Data for the solubility of iodine in aq. 40% ethyl alcohol and aq. 60% ethyl alcohol solutions of potassium iodide at 25°, are given by Parsons and Corliss, 1910. The solid phases were identified in each case and it was demonstrated that no polyiodides of potassium exist in the solid phase or in solution at 25°.

SOLUBILITY OF IODINE IN 95% ETHANOL AT LOW TEMPERATURES

(Skvirskaya and Reizer, 1953)

The authors cooled 10% iodine tinctures in 95% C₂H₅OH and analyzed the supernatant liquid iodometrically. Different determinations indicated a precision of $\pm .2$.

t°	Gms. I ₂ per 100 ml. sat. sol.	t°	Gms. I ₂ per 100 ml. sat. sol.	t°	Gms. I ₂ per 100 ml. sat. sol.
0	9.7	-25	7.1	-50	5.4
-5	9.3	-30	6.6	-55	5.2
-10	8.7	-35	6.3	-60	5.0
-15	8.1	-40	5.8	-65	4.8
-20	7.6	-45	5.6	-70	4.7

I IODINE

SOLUBILITY OF IODINE IN ABSOLUTE ETHANOL

t°	Gms. I ₂ per 100 gms. sat. sol.	Author
0	16.72	(Hildebrand, Benesi and Mower, 1952)
15	18.7 (99.82)	(Delepine and Arquet, 1928)
25	21.0	(" " ")
	21.43	(Hildebrand, Benesi and Mower, 1952)
35	24.6	(" " " ")

SOLUBILITY OF IODINE IN AQUEOUS n-PROPANOL AT 15° (Bruner, 1898)

Vol. % C ₃ H ₇ OH in Solvent	Gms. I per 100 cc Solution	Vol. % C ₃ H ₇ OH in Solvent	Gms. I per 100 cc Solution
10	0.05	60	2.71
20	0.11	70	4.10
30	0.40	80	6.05
40	0.94	90	9.17
50	1.64	100	14.93

DISTRIBUTION OF IODINE BETWEEN AMYL ALCOHOL AND WATER AND BETWEEN AMYL ALCOHOL AND AQUEOUS POTASSIUM IODIDE SOLUTIONS AT 25° (Herz and Fischer, 1904)

The original results were plotted on cross-section paper, and the following tables made from the curves.

The original figures for 5N/10 and 10N/10 KI solutions give practically identical curves.

Millimols I per 10 cc. Amyl Alcohol Layer in Each Case	Millimols I per 10 cc. of H ₂ O and of Aq. KI Layers					
	H ₂ O	$\frac{N}{10}$ KI	$\frac{2N}{10}$ KI	$\frac{3N}{10}$ KI	$\frac{4N}{10}$ KI	$\frac{10N}{10}$ KI
2.5	0.012	0.135	0.160	0.170	0.170	...
3.0	0.014	0.150	0.185	0.200	0.200	0.160
4.0	0.018	0.180	0.235	0.255	0.270	0.240
5	0.021	0.210	0.280	0.315	0.340	0.315
6	0.025	0.230	0.330	0.375	0.410	0.390
7	0.029	0.250	0.375	0.430	0.480	0.470
8	...	0.260	0.420	0.490	0.550	0.555
9	...	0.270	0.450	0.550	0.620	0.640
10	...	0.280	0.470	0.605	0.690	0.720
12	...	...	0.490	0.700	0.830	0.900
14	...	...	0.510	0.790	0.980	1.200
20	...	...	0.575	...	...	...

(Cont.)

DISTRIBUTION OF IODINE BETWEEN AMYL ALCOHOL AND WATER AND BETWEEN AMYL ALCOHOL AND AQUEOUS POTASSIUM IODIDE SOLUTIONS AT 25°--Cont.

Gms. I per 100 cc. Amyl Alcohol Layer in Each Case	Gms. I per 100 cc. of H ₂ O and of KI Layers					
	H ₂ O	$\frac{N}{10}$ KI	$\frac{2N}{10}$ KI	$\frac{3N}{10}$ KI	$\frac{4N}{10}$ KI	$\frac{10N}{10}$ KI
3	0.014	0.164	0.20	0.21	0.21	...
4	0.016	0.196	0.24	0.26	0.26	0.21
6	0.026	0.252	0.34	0.38	0.40	0.37
8	0.033	0.297	0.43	0.49	0.54	0.51
10	0.040	0.328	0.51	0.61	0.67	0.69
12	...	0.341	0.58	0.73	0.81	0.84
14	...	...	0.60	0.83	0.95	1.00
16	...	...	0.63	0.91	1.09	1.20
18	...	...	0.64	...	...	...
25	...	...	0.71	...	...	...

SOLUBILITY OF IODINE IN AQUEOUS GLYCOL SOLUTIONS AT 25°
(Osool and Pines, 1952)

Volume % glycol in Solvent		Density Sat. Sol.	Gms. I ₂ per 100 cc. sat. sol.	Volume % glycol in Solvent		Density Sat. Sol.	Gms. I ₂ per 100 cc. sat. sol.

Ethylene Glycol

15	1.0194	0.0518
30	1.0388	0.0893
45	1.0564	0.1584
60	1.0793	0.4277
75	1.0972	1.043
90	1.1269	3.394
100	1.1605	7.163

Triethylene Glycol

30	1.0523	0.1773
45	1.0737	0.4806
60	1.1031	1.704
75	1.1547	6.740
90	1.2759	21.93
95	1.3301	29.26
100	1.3854	36.71

Diethylene Glycol

15	1.0198	0.0609
30	1.0427	0.1189
45	1.0676	0.3234
60	1.0922	1.067
76	1.1283	3.986
90	1.2078	13.72
100	1.2742	17.49

Propylene Glycol

45	1.0336	0.2124
60	1.0422	0.6174
75	1.0537	1.874
90	1.0815	5.907
95	1.1029	8.835
100	1.1345	13.01

Dipropylene Glycol

30	1.0364	0.6368	90	1.4500	48.78
60	1.0570	2.738	95	1.6416	69.41
75	1.1221	10.78	100	1.7804	88.16

DISTRIBUTION OF IODINE BETWEEN CARBON TETRACHLORIDE AND WATER--Cont.

Tsing-Lien Chang (1944) found the distribution of iodine between CCl_4 and D_2O to be 103:1 at 25° , compared with 85:1 for CCl_4 and H_2O at the same temperature.

DISTRIBUTION OF IODINE BETWEEN CARBON TETRACHLORIDE AND AQUEOUS SOLUTIONS

- BaI_2 aq. Data for the distribution of iodine between aqueous solutions of barium iodide and carbon tetrachloride at 25° are given by Pearce and Eversole, 1924.
- HBr aq. Data for the distribution of iodine between aqueous solutions of hydrobromic acid and carbon tetrachloride at 30° are given by R  y and Sarker, 1922.
- NaI aq. Data for the distribution of iodine between aqueous solutions of sodium iodide (0.4933 and 0.994 gm. mols. per liter) and carbon tetrachloride at 25° are given by Carter, 1928.
- HgBr_2 aq. Data for the distribution of iodine between carbon tetrachloride and aqueous solutions of mercuric bromide and of mercuric chloride at 25° are given by Herz and Paul, 1914.
- HgCl_2 aq. Data for 0.1-3.0 N KI solutions at 5° , 12° , 20° and 30° in equilibrium with CCl_4 (originally containing 8-60 mg I_2 per 10 cc.) are given by Kitahara, 1950.
- KI aq. Results for the distribution of I_2 between aq. KI and various mixtures of $\text{CCl}_4 + \text{CS}_2$ and $\text{CCl}_4 + \text{C}_6\text{H}_5\text{CH}_3$ are given by Dawson, 1902.

DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND WATER

At 15° (Dawson, 1902)
Gms. Iodine per Liter

H_2O Layer	CS_2 Layer
0.0452	27.85
0.0486	30.09
0.0486	30.31

At 25° (Herrero, 1931, 1932, 1936)

The author found that the solubility of iodine in water is not appreciably affected by the presence of carbon disulfide. He found 0.2691 gms. I per liter pure water at 18° and 0.2876 gms. at 20° . Practically identical figures were obtained when water sat. with CS_2 was used instead of pure water.

Gms. I per liter of:		$\frac{g}{w}$
CS_2 layer (c)	H_2O layer (w)	
41.3694	0.06797	592
60.1506	0.09999	602
78.6780	0.12994	605
85.6575	0.14009	611
98.4744	0.15862	620
126.1386	0.20100	627
137.5596	0.21496	639
152.7876	0.23476	650

(Cont.)

DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND WATER--Cont.

(Jakowkin, 1895)
Gms. I₂ per liter

H ₂ O layer	CS ₂ layer
0.05	30
0.10	60
0.15	91
0.20	126
0.25	160

The distribution of iodine between CS₂ and water at total concentrations of 10⁻¹ to 10⁻⁶ molar at pH 1, 3, 5, 7, at 25° was studied by Good, 1955; Good and Edwards, 1956.

DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND AQUEOUS SOLUTIONS

K ₂ C ₂ O ₄ aq.	Concentration of Aq. K ₂ C ₂ O ₄	Gms. I per Liter of		
		Aq. Layer	CS ₂ Layer	
	1.0 Equiv.	2.408	10.82	(Dawson, 1906; Dawson and McRae, 1902)
	1.0 "	3.555	16.32	
	1.0 "	5.766	27.91	
	1.0 "	6.861	34.01	
	1.2 "	3.525	17.07	

CdI₂ aq. Data for the distribution of iodine between carbon disulfide and aqueous solutions of each of the following
 LaI₃ aq. iodides at 25° are given by van Name and Brown, 1917.
 NiI₂ aq. Cadmium iodide, cadmium potassium iodide, lanthanum iodide,
 SrI₂ aq. nickel iodide, strontium iodide, zinc iodide and zinc po-
 ZnI₂ aq. tassium iodide. Results for the distribution of iodine be-
 KI aq. tween carbon tetrachloride and aq. mercuric potassium iodide are also given.

BaI₂ aq. Results for distribution between CS₂ and aq. BaI₂ sols. are given by Herz and Kurzer, 1910.

KI aq. Data for the distribution of iodine between carbon disulfide and aqueous solutions of potassium iodide at 15° and at 13.5°, and between carbon disulfide and aqueous solutions of hydriodic acid at 13.5°, are given by Dawson, 1901 and 1902.

HCl aq. Data for the distribution of iodine between aqueous solutions of hydrochloric acid and carbon disulfide at 25° are given by Ráy and Sarkar, 1922.

KI aq. Results for the distribution of iodine between 0.1 N KI and varying mixtures of CS₂ + C₆H₆, CS₂ + C₆H₅CH₃, CS₂ + light petroleum, CS₂ + CHCl₃, are given by Dawson, 1902.

DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND AQ.
ETHYL ALCOHOL AT 25°
(Osaka, 1903-08)

Gms. C ₂ H ₅ OH per 100 cc. Aq. Alcohol	Gms. Iodine per Liter				Gms. C ₂ H ₅ OH per 100 cc. Aq. Alcohol	Gms. Iodine per Liter			
	CS ₂	Layer c	Aq. Alcohol Layer c'	$\frac{c}{c'}$		CS ₂	Layer c	Aq. Alcohol Layer c'	$\frac{c}{c'}$
7.6	0.072		35.86	0.0020	19.1	0.330		97	0.0034
7.6	0.211		107.79	0.0020	22.9	0.115		23.78	0.0048
11.4	0.077		32.93	0.0023	22.9	0.418		89.61	0.0047
11.4	0.280		133.22	0.0021	26.7	0.0756		9.8	0.0077
15.3	0.075		25.61	0.0029	26.7	0.495		65.10	0.0076
15.3	0.315		115.34	0.0027	30.5	0.0636		4.90	0.0130
19.1	0.045		13.42	0.0034	30.5	0.546		42.27	0.0129

Data for the distribution of iodine between water and mixtures of CS₂ + CCl₄ at 25° are given by Herz and Kurzer, 1910.

DISTRIBUTION OF IODINE BETWEEN WATER AND VARIOUS ORGANIC LIQUIDS

Nitrobenzene + Water

At 18° (Dawson, 1908) Moles I per liter of:		At 20° (Herrero, 1933) Gms. I per liter of:		
H ₂ O layer	C ₆ H ₅ NO ₂ layer	C ₆ H ₅ NO ₂ layer (c)	H ₂ O layer (w)	$\frac{c}{w}$
0.00019	0.0333	10.28	0.05230	196
0.00050	0.0854	14.38	0.07371	195
0.00133	0.2275	19.00	0.09593	198
0.00189	0.3328	23.17	0.11815	196
		31.06	0.15762	196
		37.98	0.18343	196
		44.14	0.22532	196

Nitrobenzene + Solutions of Aqueous Iodides at Room Temperature
(Dawson and Goodson, 1904)

Similar results are also given for solutions containing KI in addition to the other iodide, and one series for the simultaneous solubility of KBr and I in nitrobenzene. It is considered that the increased solubility is most easily explained on the assumption that periodides are formed in solutions.

Solutions are saturated with iodine in each case.

Iodide	Gms. per Liter		Iodide	Gms. per Liter	
	Iodide	Iodine		Iodide	Iodine
Potassium Iodide	12.35	112.7	Ammonium Iodide	69.5	482
" "	45.56	295.7	Ammonium Iodide*	94.3	669
" "	115.8	698.2	Aniline Hydriodide	164	721
" "	155.2	943.6	Dimethylaniline		
Sodium Iodide	13.55	125	Hydriodide	160	626
" "	57.7	393	Tetramethylammonium		
" "	109.1	738	Iodide	49.3	266

*Solvent = o-nitrotoluene instead of benzene

DISTRIBUTION OF IODINE BETWEEN WATER AND VARIOUS ORGANIC LIQUIDS--Cont.

Nitrobenzene + Solutions of Aqueous Iodides at Room Temperature--Cont.

Iodide	Gms. per Liter		Iodide	Gms. per Liter	
	Iodide	Iodine		Iodide	Iodine
Sodium Iodide	228	1251	Tetramethylammonium Iodide	51.4	280
Rubidium Iodide	85.4	421	Strontium Iodide	106.5	599
Rubidium Iodide	217.5	1060	Barium Iodide	42.2	237
Lithium Iodide	84.1	642	Barium Iodide	158.5	809
Cesium Iodide*	48.2	213			
Cesium Iodide	223	858			

*Solvent = o.nitrotoluene instead of nitrobenzene.

<u>Benzene + Water at 20°</u> (Herrero, 1933)			<u>Ethylene bromide + Water at 20°</u> (Herrero, 1933)		
Gms. I per liter of:			Gms. I per liter of:		
C ₆ H ₆ layer (c)	H ₂ O layer (w)	$\frac{c}{w}$	CH ₂ Br.CH ₂ Br layer (c)	H ₂ O layer (w)	$\frac{c}{w}$
12.972	0.03499	368			
20.432	0.05498	371			
41.240	0.10997	375	20.40	0.03137	650
56.261	0.14621	385	39.12	0.05881	665
79.984	0.20245	395	62.46	0.09149	683
90.633	0.22494	403	92.29	0.13331	692
97.226	0.23869	407	127.43	0.18298	696
105.749	0.25868	409			

Results for the distribution of iodine between 0.1 N KI solution and mixtures in varying proportions of benzene + toluene, benzene + chloroform, and benzene + light petroleum are given by Dawson, 1902.

<u>Trichlorethylene + Water</u>				<u>Bromoform + Water</u> at 25° (Jakowkin, 1895)	
At 20° (Herrero, 1933)			at 25° (Herz and Rathman, 1913)	Gms. I per liter of	
Gms. I per liter of:			Mols. Iodine per Liter	H ₂ O layer	CHBr ₃ layer
CCl ₂ .CHCl ₁ layer (c)	H ₂ O layer (w)	$\frac{c}{w}$	H ₂ O Layer CHCl ₁ .CCl ₂ Layer		
2.749	0.02499	110		0.05	20
5.098	0.04498	113	0.00046	0.10	45
7.748	0.06623	117	0.00070	0.15	71
10.872	0.07873	119	0.00112	0.20	100
17.033	0.14246	119.6	0.00236	0.25	130
22.832	0.18870	121			
30.242	0.24994	121			

DISTRIBUTION OF IODINE BETWEEN WATER AND VARIOUS ORGANIC LIQUIDS--Cont.

Chloroform + Water at 25° (Herz & Kurzer, 1910) Mols. Iodine per Liter		Tetrachlorethylene + Water at 25° (Herz & Rathmann, 1913) Mols. Iodine per Liter	
H ₂ O Layer	CHCl ₃ Layer	H ₂ O Layer	CCl ₂ .CCl ₂ Layer
0.00025	0.0338	0.00088	0.0653
0.00120	0.1546	0.00127	0.0932
0.00184	0.2318	0.00172	0.1285
0.00259	0.3439	0.00281	0.2161
0.00335	0.2343		

Tetrachlorethane + Water at 25° (Herz & Rathmann, 1913) Mols. Iodine per Liter		Pentachlorethane + Water at 25° (Herz & Rathmann, 1913) Mols. Iodine per Liter	
H ₂ O Layer	C ₂ H ₂ Cl ₄ Layer	H ₂ O Layer	C ₂ HCl ₃ Layer
0.00119	0.1101	0.00092	0.0848
0.00145	0.1247	0.00117	0.1067
0.00159	0.1479	0.00160	0.1434
0.00217	0.2103	0.00204	0.1963

*Schilow and Lepin, 1922. (excess iodine present)

DISTRIBUTION OF IODINE AT ROOM TEMPERATURE BETWEEN AQUEOUS STARCH SOLUTIONS AND CHLOROFORM
(Firth and Watson, 1922)

Ten cc. of a chloroform solution of iodine was shaken with 10 cc. of the starch solution for 10 minutes and after separation of the two layers, the iodine remaining in the CHCl₃ layer was determined by titration with standard thiosulfate solution.

The results show that the amount of iodine withdrawn from the CHCl₃ is proportional to the concentration of the starch. The authors also give results showing the effect of various amounts of KI in the starch solution upon the amount of iodine withdrawn from the CHCl₃.

Gms. I per liter in the original CHCl ₃ sol.	Gms. I per liter in the starch solution containing			
	4 gms. starch per liter	2 gms. starch per liter	1 gm. starch per liter	0.5 gm. starch per liter
0.15204	0.02534	0.015175	0.007587	0.004434
0.1267	0.02281	0.011405	0.006235	0.003794
0.11403	0.02154	0.010135	0.006335	0.003467
0.10136	0.02027	0.010135	0.005712	0.002534
0.08869	0.01901	0.009505	0.005068	0.002534
0.07602	0.01584	0.008535	...	...

Several determinations of the reciprocal solubility of Iodine, Ethyl Ether and Water at 20° are given by Nesteroro and Petine, 1931.

I IODINE

DISTRIBUTION OF IODINE BETWEEN TOLUENE AND WATER AT 25° (Schilow and Lepin, 1922)

Gms. I per 100 cc. saturated*		$\frac{T}{W}$
H ₂ O layer (W)	Toluene layer T	
0.036	3.50	97.5

*excess iodine present.

SOLUBILITY OF IODINE IN VARIOUS ORGANIC SOLVENTS

Acetone	(Jasek, 1915) Gms. I per 100 gms. CH ₃ .CO.CH ₃		t°	Gms. I per 100 gms. CH ₃ .CO.CH ₃		t°	Gms. I per 100 gms. CH ₃ .CO.CH ₃	
	-84	2.73		-51.0	12.1		-22.5	4.5
	-75	6.76		-44.5	8.6		-18.0	4.25
	-70.5	8.83		-42.0	8.6		-16.0	3.9
	-54.75	15.06		-34	6.54		-5.0	2.66
	-53.5	13.5		-30	5.30		0.0	2.56
Benzene	(Arctowski, 1895-96) Gms. I per 100 Gms. Solution		t°	(Hildebrand and Jenks, 1920) Gms. I per 100 Gms. sat. sol.		t°	Mols. I ₂ per 100 mole. sat. sol.	
	4.7	8.08		20	(8.15)*a		....	....
	6.6	8.63		25	14.09		0.0480	....
	10.5	9.60			(13.83)†		....	....
	13.7	10.44		30	16.10		0.0558	....
	16.3	11.23			(11.64)*		....	....
				35	17.90		0.0629	....
				40	20.05		0.0716	....
				45	22.78		0.0832	....
				50	25.51		0.0953	....
				54.64	28.26		0.1081	....
Chloroform	(Below 0°, Jasek, 1915; Arctowski, 1895-96; above 0°, Grimbert, Malmy and Piriou, 1924; Malmy, 1926; Margosches, Rinner and Friedmann, 1924)		t°	Gms. I per 100 gms. CHCl ₃		t°	Gms. I per 100 cc. sat. sol.	
	-73.5	0.080 (A.)		-25	0.404		10	1.805(1.76)†
	-69.5	0.089 (A.)		-22.25	0.514		11	...
	-60	0.089		-9	0.856		15	2.176
		(0.129)(A.)		-5	1.054		18	...
	-55.5	0.144 (A.)		-1	1.198 (M.)		19	...
	-51	0.128		0	1.240		20	2.630
	-49	0.188 (A.)		0	1.237 (M.)		21	...
	-45.5	0.180		+0.5	1.267 (M.)			3.95(3.38*)
	-35.0	0.243		5.0	1.483		24	3.092
	-30	0.372					25	3.200
							30	3.836 (M.)

*Schilow and Lepin, 1922.

†Duncan, 1891-92.

**Hera and Rathman, 1913.

~ 100 gms. chloroform for anesthesia, containing 0.005 per cent C₂H₅OH, dissolve 2.19 gm. I at 15°. (G. M. and F.)

Solubility results on mixtures of Iodine and Potassium Iodide with Chloroform and with Toluene, given by Foote and Bradley, 1932, show that between 0.7° and 25.0° no solid binary addition product of Iodine and Potassium Iodide exists. With benzene a ternary addition product having the composition KI.4I₂.3C₆H₆ was found.

SOLUBILITY OF IODINE IN VARIOUS ORGANIC SOLVENTS--Cont.
Carbon tetrachloride (Jacek, 1926; Hildebrand and Jenks, 1920; Margoshes, Hinner and Friedman, 1924)

per 1 t°	Gms. I per 100		t°	Gms. I per 100		t°	Gms. I per 100	
	gms. CCl ₄			gms. CCl ₄			Gms. CCl ₄	cc. sat. sol.
-24.75	0.254	-9.5	0.466	11	...	...	1.77(M.H.&F.)
-24.0	0.257	-8.5	0.480	11.5	...	...	1.83*
-22.0	0.270	-8.25	0.496	15	...	...	2.05(M.H.&F.)
-19.0	0.297	-7.25	0.527	18	...	...	2.25(")
-18.5	0.319	-6.00	0.539	21	...	...	2.51(")
-17.0	0.327	-2.75	0.632	25	...	...	2.91(")
-16.5	0.352	0.0	0.733	...	...	...	3.03†
-14.5	0.375	0.0	0.693	...	...	...	3.01**
-11.25	0.447		(H. and J.)	35	2.667(H.&J.)	...		
		0.0	(1.04)*	50	4.547(")	...		

*Gms. per 100 cc. sat. sol. (Groh, 1927).
† " " " " " " (Jakowkin, 1895)
** " " " " " " (Herz and Rathmann, 1913).

MUTUAL SOLUBILITY OF LIQUID IODINE AND CARBON TETRACHLORIDE
(Hildebrand, 1937)

The determinations were made by the synthetic method but due to the opacity of concentrate iodine solutions advantage was taken of the difference in density of the two liquid phases for detecting their points of separation.

t°	Wt. % Iodine	Mol. % Iodine	t°	Wt. % Iodine	Mol. % Iodine
128.8	44.8	33.0	160.5(max.)	..	67.0
155.0	63.0	50.8	160.1	80.8	71.8
158.1	67.0	55.1	159.9	81.7	73.1
160.6	76.0	65.7	153.5	86.6	79.7

Carbon disulfide

Results at low temperatures (Jacek, 1915)

t°	Gms. I per 100 gms. CS ₂	t°	Gms. I per 100 gms. CS ₂	t°	Gms. I per 100 gms. CS ₂
-107	0.158	-69	0.520	-29.5	2.597
-80	0.255	-51	1.089	-22.25	3.541
-77.5	0.342	-45	1.361	-15.75	4.544
-71.5	0.422	-35.25	2.007	-5	6.788
				0	8.385

Results at higher temperatures (Arctowski, 1894)

t°	Gms. I per 100 Gms. Solution	t°	Gms. I per 100 Gms. Solution	t°	Gms. I per 100 Gms. Solution
-100	0.32	0	7.89 (7.69)*	30	19.26
-80	0.51	10	10.51	35	21.65*
-63	1.26	15	12.35	36	22.67
-20	4.14	16.6	[17.85]†	40	25.22
-10	5.52	20	14.62	42	26.75
		25	16.92(16.47)*		

*Hildebrand, Benesi and Mower, 1950
†Gms. per 100 cc. sat. sol. - Strömholm, 1903.

SOLUBILITY OF IODINE IN VARIOUS ORGANIC SOLVENTS--Cont.

(Jacek, 1915)

Ethyl ether	t°	Gms. I per 100 gms. (C ₂ H) ₂ O	t°	Gms. I per 100 gms. (C ₂ H) ₂ O	t°	Gms. I per 100 gms. (C ₂ H) ₂ O
	-108	15.10(15.09)*	-51	16.44	-21	20.38
	-94.5	15.43	-47	17.08	-19.5	20.80
	-83.25	15.46(15.39)*	-40.25	17.67	-14.75	21.59
	-75	15.67	-34.75	18.64	0.0	26.08(23.98)†
	-63	16.16	-24.5	19.67		(16.73)**
					16.6	20.63**
					25	33.7†
					35	39.9†

*Arctowski, 1895-96.

†Hildebrand, Benesi and Mower, 1950.

**Gms. per 100 cc. sat. sol. - Stromholm, 1903.

n-Pentane
iso-Pentane

(Jacek, 1926)

Results for Normal Pentane			Results for Iso Pentane		
t°	Gms. I per 100 gms. CH ₃ (CH ₂) ₃ CH ₃		t°	Gms. I per 100 gms. (CH ₃) ₂ CHCH ₂ CH ₃	
-71.25	0.018		-79.25	0.017	
-69.75	0.021		-66.25	0.018	
-54.25	0.042		-56.00	0.033	
-48.75	0.057		-49.0	0.039	
-45.25	0.067		-42.5	0.063	
-40.75	0.078		-37.5	0.080	
-34.25	0.113		-36.95	0.089	
-26.75	0.160		-34.25	0.096	
-26.0	0.171		-31.5	0.117	
-15.25	0.297		-25.25	0.155	
-7.0	0.423		-23.5	0.172	
-5.5	0.483		-21.0	0.200	
0.0	0.605		-10.0	0.345	
+19.0	1.377		-8.0	0.381	
			-8.0	0.375	
			0.0	0.562	

n-Hexane 100 gms. of sat. sol. at 25° contain 12.2 gms. iodine. (Hildebrand and Jenks, 1920).

2,2-Dimethyl butane t° 0 25 35
gms. I per 100 gms. sat. sol. 0.481 1.369 1.988
(Hildebrand, Benesi and Mower, 1950)

Cyclohexane (Kortüm and Kortüm-Seiler, 1950) (Hildebrand, Benesi and Mower, 1950)

t°	17	20	25	35
gms. I per 100 gms. sat. sol.	2.005	2.255	2.719	3.903

n-Heptane (Hildebrand and Jenks, 1920)

t°	Gms. I per 100 gms. sat. sol.	Mols. I ₂ per 100 mols. sat. sol.
0	0.6176	0.00245
25	1.702	0.006786
35	2.491	0.00998
50	4.196	0.01699

Perfluoro-n-heptane t° 0 25 35
gms. I per 100 gms. sat. sol. 0.0025 0.0120 0.0187
(Hildebrand, Benesi and Mower, 1950)
(McLaughlin and Scott, 1954)

iso-Octane t° 24.92 35
gms. I per 100 gms. sat. sol. 1.302 1.918 (Negishi, Donnally and Hildebrand, 1933)

Toluene at 25°, 100 cc. of sat. sol. contain 3.56 gms. iodine. (Schilow and Lepin, 1922)

p-Xylene t° 25 35
gms. I per 100 gms. sat. sol. 16.56 20.13 (Hildebrand, Benesi and Mower, 1950)

SOLUBILITY OF IODINE IN VARIOUS ORGANIC SOLVENTS--Cont.

Mesitylene	t°	0	25	(Hildebrand, Benesi and Mower, 1950)
gms. I per 100 gms. sat. sol.		13.51	20.25	

(Data of Margosches, Hinner and Friedman, 1924)

Gms. I ₂ per 100 cc sat. solution in:				
	Methylene Chloride CH ₂ Cl ₂	Tetrachloro Ethylene CCl ₂ .CCl ₂	Trichloro Ethylene CHCl.CCl ₂	1,1 Dichloro Ethylene CH ₂ CCl ₂
t°				
Methylene chloride				
Tetrachloroethylene				
Trichloroethylene				
1,1 Dichloro ethylene				
1,1,2,2 Tetrachloro ethane				
Ethylene chloride	11 3.68	1.87	2.48	2.99
1,2 Dichloro ethane	15 4.22	2.10	2.80	3.38
1,1 Dichloro ethane	18 4.65	2.32	3.05	3.72
	21 5.13	2.59	3.41(3.88)**	4.13
	25 5.86	3.06(3.059)*	3.96(3.961)*	4.76

Gms. I₂ per 100 cc sat. solution in:

t°	Pentachloro Ethane CHCl ₂ .CCl ₃	1,1,2,2 Tetre chloro ethane CHCl ₂ .CHCl ₂	Ethylene Chloride CH ₂ .CHCl	1,2 Dichloro ethane CH ₂ Cl.CH ₂ Cl	1,1 Dichloro ethane CH ₃ .CHCl ₂
11	2.02	2.71	3.72	4.59	4.00
15	2.31	3.01	4.15	5.11	3.25
18	2.50	3.22	4.50	5.59	3.49
21	2.86	3.61	4.91	6.13	3.92
25	3.09(3.453*)	4.10(3.097*)	5.47	6.87	4.39

*Herz and Rathmann, 1913.

†Grace, 1931.

**Herrero, 1933 at 20°.

(Data of Benesi and Hildebrand, 1948)

Solvent	Grams per 100 grams of Saturated Solution		
	15°	25°	35°
Ethylene Chloride	3.912	5.44	7.39
Ethylidene Chloride	...	3.826	5.245
cis-Dichloroethylene	2.597	3.686	5.173
trans-Dichloroethylene	...	3.628	5.048

Bromoform	t°	Solubility	Author
5.6	3.22 gms. per 100 gms. sat. sol.		(Asadori, 1922)
25	5.6 " " " "		(Turner and English, 1944)
25	18.96 gms. per 100 cc. sat. sol.		(Jakowkin, 1895)

Nitrobenzene	At 16-17° 100 cc sat. sol. contain 5.06 gms. iodine	(Dawson and Gawler, 1902)
	" 20° " " " " " 5.646 " "	(Herrero, 1933)

An extensive series of determinations of the simultaneous solubility of iodine and potassium iodide in nitrobenzene and in other organic solvents, as well as in mixtures of nitrobenzene and other solvents are given by Dawson and Gawler, 1902, and Dawson, 1904. The determinations were made to obtain information on the formation of polyiodides in solution. The molecular ratio of dissolved I₂/XI was found to be 1 or more in all cases.

Acetic acid	At 20° 100 gms. sat. sol. contain 1.727 gms. iodine	(Anders, 1933)
	" 30° " " " " " 2.706 " "	

Ethyl acetate	At 8° 100 gms. sat. sol. contain 11.1 gms. iodine	(Knott, 1932)
	" 11° " " " " " 12.39 " "	
	" 30° " " " " " 16.15 " "	

(Data of Negishi, Dannally and Hildebrand, 1933)

Gms. I ₂ per 100 gms. sat. sol.		Gms. I ₂ per 100 gms. sat. sol.		Gms. I ₂ per 100 gms. sat. sol.	
t°		t°		t°	
8	6.557	25	10.32	60	25.54
10	6.850	35	13.42	70	33.30
15	7.859	45	17.43	75	37.61
20	9.091*	49.5	19.12	78.4	42.40

*20.103 gms. per 100 cc sat. sol. at 20°. (Herrero, 1933).

I IODINE

SOLUBILITY OF IODINE IN VARIOUS ORGANIC SOLVENTS—Cont.

Perfluoro-tri-n-butyl amine (C_4F_9) ₃ N	t°	25	35	45	
	gms. I per 1000 gms. solvent	0.0880	0.1443	0.2544	(McLaughlin and Scott, 1954)
Perfluoro n-propylpyran ($C_8F_{16}O$)	t°	25	35	45	
	gms. I per 1000 gms. solvent	0.127	0.208	0.375	(McLaughlin and Scott, 1954)

Pyridine (+H₂O)

Equilibrium in the System Iodine, Pyridine and Water at 18°
(Chatelet, 1934)

The solubility of iodine in pyridine was found to be about 450 gms. I per 1000 cc of sat. solution at 18°. From such a solution upon evaporation, clear yellow needles separate, but within 2-5 minutes they begin to decompose with liberation of iodine.

In the case of the mixtures of iodine, pyridine and water they were agitated about 15 minutes and then filtered through a porous glass disc. The clear filtrate and several samples of the mixture of solid and solution were analysed. The results when plotted indicate the formation of two molecular compounds.

Gms. per 100 gms. sat.
solution

I ₂	C ₅ H ₅ N	H ₂ O	Solid Phase
3.6	47.5	48.9	I ₂ (C ₅ H ₅ N) ₂ ·29(?)H ₂ O
1.0	33.9	65.1	"
1.5	24.1	74.1	"
2.7	9.0	88.3	I ₂ (C ₅ H ₅ N)·6H ₂ O
2.0	8.4	89.6	"
1.1	6.1	92.8	"

Acetic acid (+H₂O)

(Results of McLaughlin, 1903 at 25°)

Since McLaughlin's value for the solubility of iodine in water was apparently too low, the figures 0.034 gm. per 100 cc was substituted and used as a basis for calculating the remaining results for the solubility of iodine in acetic acid.

Gms. CH ₃ COOH per 100 Gms. Solvent	Gms. I per 100 cc. Sat. Solution	Gms. CH ₃ COOH per 100 gms. Solvent	Gms. I per 100 cc. Sat. Solution
0	0.034	61.1	0.510
20	0.076	80.7	1.363
39.5	0.173	100	3.162

Lanolin
(anhydrous, m.pt.
46°)

At 45°, 100 gms. of sat. sol. contain 5.5 gms. of iodine. (Klose, 1907)

Iodoform

Freezing-Points of Mixtures of Iodine and Iodoform
(Vasilev, 1916; see also Olivari, 1911)

t°	I content of mixture		Solid Phase	t°	I content of mixture		Solid Phase
	Wt. %	Atom %			Wt. %	Atom %	
114.0	100.0	100.0	I	66.1 (Eutec.)	42.3	...	I + CHI ₃
97.8	87.84	95.70	"	70.9	38.85	66.33	CHI ₃
94.8	85.38	94.82	"	78.1	31.45	58.76	"
79.8	70.22	87.98	"	86.2	24.63	50.35	"
73.6	59.41	81.96	"	95.8	17.63	39.40	"
71.2	53.30	77.96	"	111.9	5.20	14.55	"
69.5	49.08	74.94	"	119.7	0.0	0.0	"

Naphthalene

Similar data for iodine + Naphthalene gave a single eutectic at 650.7 and 39.43 wt. % I.

Other compounds

Diagrammatic results for mixtures of iodine and each of the following compounds are given by Olivari, 1911: p-C₆H₄Br₂, [C₆H₄]N₂, p-C₆H₄(NO₂)₂, (C₆H₅CO)₂O, C₆H₅COOH, (CH₃)₃NI, and (CH₃)₃(C₆H₅)NI.

SOLUBILITY OF IODINE IN MIXTURES OF CHLOROFORM AND ETHER AT 25°

(Marden and Dover, 1916)

Gms. CHCl ₃ per 100 Gms. CHCl ₃ + (C ₂ H ₅) ₂ O	Gms. Iodine per 100 Gms. CHCl ₃ + (C ₂ H ₅) ₂ O	Gms. CHCl ₃ per 100 Gms. CHCl ₃ + (C ₂ H ₅) ₂ O	Gms. Iodine per 100 Gms. CHCl ₃ + (C ₂ H ₅) ₂ O
0	35.1	60	9.83
10	29.6	70	7.5
20	24.8	80	5.73
30	20.2	90	4.31
40	16.3	100	3.10
50	12.7		

100 cc. of a mixture of CHCl₃ + CS₂ (3:1) dissolve 7.39 gms. iodine (t° ?). The addition of S even up to the point of saturation does not affect the amount of iodine held in solution. (Olivari, 1908).

ETHYL ETHER + WATER

ETHYL ETHER + ETHANOL

ETHYL ETHER + CARBON DISULFIDE

ETHYL ETHER + CHLOROFORM

ETHYL ETHER + BENZENE

ETHYL ETHER + IODOFORM

CARBON DISULFIDE + CHLOROFORM

At 16.6°

(Strömholm, 1903)

Solvent	Gms. I per Liter Sat. Sol.	Solvent	Gms. I per Liter
Ether	206.3	Ether + 20.96 gms. CS ₂ per liter	202.3
Carbon Disulfide	178.5	Ether + 41.9 " CS ₂ "	217.2
Ether + 3.96 gms. H ₂ O per liter	221	CS ₂ + 22.5 " ether "	189.3
" + 7.91 gms. H ₂ O "	235.7	CS ₂ + 45.1 " ether "	201.1
" + excess H ₂ O	251.4	Ether + 47.63 " CHCl ₃ "	195.2
" + 9.79 gms. C ₂ H ₅ OH "	219.1	CS ₂ + 50.06 " CHCl ₃ "	172.8
" + 19.6 " " "	231.5	Ether + 80.3 " C ₆ H ₆ "	204.1
" + 29.4 " " "	243.9	Ether + 77.85 " CH ₃ I "	220.2
" + 39.2 " " "	254.4		

SOLUBILITY OF IODINE IN CARBON TETRACHLORIDE CONTAINING OTHER SOLVENTS

(Groh, 1927)

CCl ₄ + Methyl Alcohol			CCl ₄ + Ethyl Alcohol			CCl ₄ + Propyl Alcohol		
Gm. Mols. per liter sat. sol. in CCl ₄			Gm. Mols. per liter sat. sol. in CCl ₄			Gm. Mols. per liter sat. sol. in CCl ₄		
t°	CH ₃ OH	I ₂	t°	C ₂ H ₅ OH	I ₂	t°	C ₃ H ₇ OH	I ₂
0	0.192	0.0524	0	0.205	0.0556	0	0.208	0.0547
"	0.411	0.0601	"	0.410	0.0653	"	0.414	0.0636
"	0.617	0.0673	"	0.609	0.0741	"	0.622	0.0721
"	0.814	0.0743	"	0.808	0.0829	"	0.815	0.0800
"	0.993	0.0806	"	1.025	0.0924	"	1.035	0.0889
"	1.234	0.0891	"	1.232	0.1015	"	1.307	0.1001
"	1.607	0.1022	"	1.621	0.1193	"	1.543	0.1096
"	2.032	0.1168	"	2.013	0.1365	"	2.045	0.1312
11.8	0.188	0.0816	11.7	0.201	0.0849	11.6	0.198	0.0835
"	0.404	0.0920	"	0.404	0.0970	"	0.403	0.0947
"	0.596	0.1006	"	0.596	0.1080	"	0.594	0.1051
"	1.011	0.1191	"	0.807	0.1202	"	0.805	0.1163
"	1.120	0.1237	"	1.010	0.1319	"	1.005	0.1267

SOLUBILITY OF IODINE IN CARBON TETRACHLORIDE
CONTAINING OTHER SOLVENTS--Cont.
(Grah, 1927)

CCl ₄ + Acetic Acid			CCl ₄ + Ethyl Ether		
t°	Gm. Mols. per liter sat. sol. in CCl ₄		t°	Gm. Mols. per liter sat. sol. in CCl ₄	
	CH ₃ COOH	I ₂		(C ₂ H ₅) ₂ O	I ₂
0	0.0	0.0450	0	0.211	0.0549
"	0.201	0.0464	"	0.422	0.0650
"	0.395	0.0477	"	0.633	0.0748
"	0.797	0.0501	"	0.844	0.0853
"	0.992	0.0513	"	1.055	0.0960
"	1.148	0.0522	"	1.266	0.1063
11.15	0.204	0.0715	11.4	0.0	0.0710
"	0.406	0.0730	"	0.196	0.0815
"	0.547	0.0744	"	0.390	0.0927
"	0.897	0.0765	"	0.585	0.1037
"	1.181	0.0786	"	0.865	0.1206
			"	1.171	0.1399

SOLUBILITY OF IODINE IN MIXTURES OF ACETIC ACID AND BENZENE
(Anders, 1933)

Results at 0°		Results at 20°		Results at 30°	
Gms. CH ₃ COOH per 100 gms. solvent mixture	Gms. I per 100 gms. sat. solution	Gms. CH ₃ COOH per 100 gms. solvent mixture	Gms. I per 100 gms. sat. solution	Gms. CH ₃ COOH per 100 gms. solvent mixture	Gms. I per 100 gms. sat. solution
21.788	3.892	0.0	8.152	0.0	11.642
47.961	3.156	21.516	7.107	21.371	9.745
58.263	3.224	39.045	6.162	42.681	7.597
		59.761	4.048	58.624	5.492
		75.407	3.011	77.623	4.224
		100.00	1.727	100.0	2.706

SOLUBILITY OF IODINE IN MIXTURES CONTAINING CHLOROFORM

Results of Mahieu, 1936. at 25°

In Ether + Chloroform (see also p. 1279) In Methyl Alcohol + Chloroform

Gms. (C ₂ H ₅) ₂ O per 100 gms. solvent mixture	Gms. I per 100 gms. solvent mixture	Gms. CHCl ₃ per 100 gms. solvent mixture	Gms. I per 100 gms. solvent mixture
0.0 (= CHCl ₃)	2.01	0.0 (= CH ₃ OH)	23.35
25.1	4.80	24.1	17.97
48.1	7.34	50.3	12.75
73.6	15.03	74.4	7.71
100.0	23.86	100.0	2.11

(Cont.)

SOLUBILITY OF IODINE IN MIXTURES OF ORGANIC SOLVENTS--Cont.

Chloroform + Ethanol
Chloroform + n.Propanol

Chloroform + Benzene
Chloroform + Carbon disulfide

At 15°
(Bruner, 1898)

Vol. % CHCl ₃ in Solvent	Gms. I Dissolved per 100 cc. of Mixtures of:			
	CHCl ₃ + C ₂ H ₅ OH	CHCl ₃ + C ₃ H ₇ OH	CHCl ₃ + C ₆ H ₆	CHCl ₃ + CS ₂
0	15.67	14.93	10.40	17.63
10	9.43	13.16	9.84	15.93
20	8.69	11.20	8.78	14.20
30	7.80	8.98	7.74	12.16
40	7.09	8.09	6.96	10.20
50	6.62	7.82	6.20	9.08
60	6.24	7.09	5.34	7.72
70	5.77	6.42	4.89	6.42
80	5.06	5.54	4.53	5.27
90	4.34	4.52	4.07	4.32
100	3.62	3.62	3.62	3.62

Carbon Tetrachloride + Benzene Carbon tetrachloride + Carbon disulfide
At 15°
(Bruner, 1898)

The volume change occurring on mixing the solvents was neglected. The temperature was not accurately regulated and the mixtures not shaken during the saturation. The curves plotted from the results are not smooth.

Vol. % CCl ₄ in Solvent	Gms. I per 100 cc. of Mixture of:		Vol. % CCl ₄ in Solvent	Gms. I per 100 cc. of Mixture of:	
	CCl ₄ + C ₆ H ₆	CCl ₄ + CS ₂		CCl ₄ + C ₆ H ₆	CCl ₄ + CS ₂
0	10.40	17.6	60	4.90	5.55
10	9.44	14.44	70	4.09	4.50
20	8.53	12.33	80	3.41	3.37
30	7.77	10.34	90	2.74	2.60
40	6.63	8.60	100	2.06	2.06
50	5.70	6.83			

IODINE

SOLUBILITY OF IODINE IN MIXTURES OF CYCLOHEXANE + DIOXANE (Kortum and Kortum-Seiler, 1950)

At 17°		At 20°		At 25°	
mole fraction		mole fraction		mole fraction	
dioxane in solvent	I ₂ in sat. sol.	dioxane in solvent	I ₂ in sat. sol.	dioxane in solvent	I ₂ in sat. sol.
0.0	0.00658	0.0	0.00740	0.0	0.00892
0.00797	0.00789	0.0136	0.00966	0.0138	0.01112
0.01179	0.00841	0.0167	0.00991	0.0207	0.01265
0.01468	0.00887	0.0190	0.01046	0.0318	0.01422
0.0219	0.00994	0.0254	0.01164	0.0319	0.01419
0.0254	0.01043	0.0319	0.01210	0.0349	0.01480
0.0273	0.01043	0.0500	0.00940	0.0390	0.01566
0.0286	0.01027	0.0549	0.00913	0.0393	0.01572
0.0407	0.00849	0.0635	0.00877	0.0431	0.01475
0.0440	0.00794	0.102	0.00845	0.0490	0.01411
0.0711	0.00707	0.130	0.00879	0.0790	0.00197
0.1012	0.00699	0.179	0.00970	0.0915	0.01165
0.119	0.00713	0.196	0.01008	0.1206	0.01171
0.134	0.00727	0.239	0.01119	0.127	0.01172
0.144	0.00742	0.304	0.01298	0.185	0.01298
0.178	0.00812	0.339	0.01410	0.322	0.01740
0.228	0.00929	0.400	0.01597	0.345	0.01845
0.299	0.01103	0.600	0.02187	0.418	0.02115
0.337	0.01203	0.771	0.02490	0.489	0.02345
0.486	0.01619	0.800	0.02530	0.625	0.02794
0.652	0.02019	0.875	0.02550	0.742	0.03045
0.692	0.02097	0.900	0.02523	0.822	0.03142
0.860	0.02259	0.934	0.02483	0.921	0.03109
1.000	0.02073	1.000	0.02366	1.000	0.02920

SOLUBILITY OF IODINE IN CYCLOHEXANE - METHYLBUTYLETHER MIXTURES AT 20° (Kortum and Kortum-Seiler, 1950)

mole fraction			mole fraction		
Me Bu ether in solvent	Me Bu ether in sat. sol.	I ₂ in sat. sol.	Me Bu ether in solvent	Me Bu ether in sat. sol.	I ₂ in sat. sol.
0.0	0.0	0.00740	0.375	0.359	0.04283
0.0259	0.0257	0.00991	0.691	0.642	0.07260
0.0578	0.0570	0.01278	0.932	0.842	0.09723
0.1667	0.1630	0.02281	1.000	0.897	0.10327

Results for the solubility of iodine in cyclohexane - ethylene bromide mixtures at 25° in diagram form are given by Kortum and Kortum-Seiler, 1950.

THE SYSTEM TETRAMETHYL AMMONIUM IODIDE - IODINE - TOLUENE

(Foote and Fleisher, 1953)

[Two to five determinations were used to locate each invariant point.]

At 6°

Wt.% iodine in			Wt.% iodine in		
Soln.	Solid	Solid Phase	Soln.	Solid	Solid Phase
0.034	50.00	MI + MI ₃	1.88	85.04	MI ₁₀
0.045	59.34	MI ₃ + MI ₅	1.94	85.07	"
0.49	71.68	MI ₅	1.99	84.99	"
0.97	71.72	"	2.00	84.98	"
1.51	71.74	"	2.19	85.02	"
1.60	83.70	MI ₅ + MI ₁₀	2.28	85.47	MI ₁₀ + MI ₁₁
1.70	85.39	MI ₁₀	2.57	86.33	MI ₁₁
1.71	85.01	"	5.71	86.41	"
1.77	84.95	"	9.41	86.67	"
1.85	84.78	"	10.31	93.79	MI ₁₁ + I ₂

At 25°

0.067	11.32	MI + MI ₃	3.26	83.55	MI ₉
0.088	59.52	MI ₃ + MI ₅	3.55	84.74	MI ₉ + MI ₁₁
0.56	71.48	MI ₅	3.64	86.33	MI ₁₁
1.95	71.77	"	4.02	86.32	"
2.56	75.91	MI ₅ + MI ₉	5.20	86.38	"
2.79	83.47	MI ₉	13.55	86.29	"
2.81	83.50	"	14.74	86.53	"
2.83	83.55	"	15.52	92.14	MI ₁₁ + I ₂
2.86	83.53	"			

M. = (CH₃)₄N

DISTRIBUTION OF IODINE BETWEEN IMMISCIBLE ORGANIC LIQUIDS

(Results of Landau, 1910)

Between Glycerol and Benzene				Between Glycerol and CCl ₄			
Gms. Iodine per Liter:				Gms. Iodine per Liter:			
t°	Glycerol Layer (a)	Benzene Layer (b)	(b) (a)	t°	Glycerol Layer (a)	CCl ₄ Layer (b)	(b) (a)
25°	0.407	1.922	4.72	25°	0.365	0.565	1.55
"	0.676	4.086	6.04	"	0.684	1.224	1.78
"	1.470	10.212	6.95	"	1.416	2.652	1.87
"	2.622	20.102	7.67	"	5.064	9.888	1.95
"	5.280	42.458	8.04	"	7.636	14.766	1.93
40°	0.459	2.168	4.72	40°	0.322	0.575	1.79
"	0.658	3.911	5.94	"	0.690	1.169	1.74
"	1.584	11.244	7.10	"	1.224	2.772	1.69
"	3.048	24.104	7.91	"	2.832	6.444	2.26
"	5.564	49.960	8.44	"	6.854	15.410	2.25
50°	0.467	2.194	4.70	50°	0.299	0.653	2.19
"	0.642	3.864	6.02	"	0.570	1.270	2.23
"	1.463	11.196	7.65	"	1.511	3.457	2.29
"	2.391	19.872	8.31	"	2.664	6.468	2.43
"	5.383	46.782	8.69	"	6.348	16.008	2.52

DISTRIBUTION OF IODINE BETWEEN GLYCEROL AND CHLOROFORM

Data are also given by the above named investigators for the distribution of iodine between aqueous glycerol solutions and chloroform at several temperatures.

DISTRIBUTION OF IODINE BETWEEN ETHER AND ETHYLENE GLYCOL
(Landau, 1910)

Results at 0°			Results at 25°		
Gms. Iodine per Liter:			Gms. Iodine per Liter:		
$(C_2H_5)_2O$	$(CH_2OH)_2$	a	$(C_2H_5)_2O$	$(CH_2OH)_2$	a
Layer (a)	Layer (b)	b	Layer (a)	Layer (b)	b
2.139	1.449	1.48	2.208	1.449	1.52
7.820	4.347	1.80	4.255	2.541	1.60
16.620	9.486	1.75	7.728	4.347	1.78
20.564	11.685	1.76	16.200	9.120	1.78
31.785	18.135	1.75	30.322	17.062	1.78
79.950	44.460	1.80	78.195	44.460	1.76

Results of Hantzsch and Vagt, 1901 at 30°

Mols. Iodine per Liter:			
t°	Glycerol Layer (c)	Ether Layer (c')	$\frac{c}{c'}$
(0)	(0.00566)	(0.0270)	(0.21)
30	0.00544	0.0272	0.20
30	0.00100	0.0051	0.20

Results at 25° (Herz & Kurzer, 1910)			Results at 30° (Hantzsch & Vagt, 1901)			Results at Dif. Temps. (Hantzsch & Vagt, 1901)			
Mols. Iodine per 1000 Gms.			Mols. Iodine per Liter:			Mols. I per Liter:			
Glycerol Layer c	CHCl ₃ Layer c'	$\frac{c}{c'}$	Glycerol Layer c	CHCl ₃ Layer c'	$\frac{c}{c'}$	t°	Glycerol Layer c	CHCl ₃ Layer c'	$\frac{c}{c'}$
0.0244	0.0564	0.43	0.00097	0.00172	0.056	0	0.0119	0.0177	0.675
0.0397	0.0910	0.43	0.00204	0.00412	0.495	20	0.0084	0.0213	0.400
0.0500	0.1151	0.43	0.00418	0.00898	0.465	40	0.0077	0.0221	0.349
			0.00782	0.0216	0.362	50	0.0074	0.0226	0.330

THE RECIPROCAL SOLUBILITY OF IODINE AND SULFUR

In Benzene at 25° (Amadori, 1922)			In Carbon Disulfide at 25° (Amadori, 1922)			In Carbon Tetrachloride (Jakowkin and Archangelsky, 1936)		
Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.			Gms. per 100 cc. sat. sol.		
I	S	Solid Phase	I	S	Solid Phase	I	S	Solid Phase
15.79	0.0	I	19.14	0.0	I	Results at 0°		
16.08	0.40	"	19.83	7.76	"	1.145	0.0	I
16.28	1.75	"	20.64	12.83	"	1.157	0.596	I + S
16.42	2.58	I + S	21.45	27.73	"	0.818	0.596	S
12.72	2.42	S	22.11	36.74	"	0.0	0.596	S
8.31	2.35	"	22.64	40.82	S + I	Results at 25°		
0.0	2.09	"	16.08	39.56	S	2.905	0.0	I
			9.4	37.12	"	3.083	1.466	I + S
			6.62	36.42	"	2.069	1.405	S
			0.0	34.76	"	1.998	1.394	S
						0.0	1.329	S

In Bromoform at 3.65°
(Amadori, 1922)

Bromoform simultaneously saturated with iodine and sulfur contains 3.7 gms. I and 4.2 gms. S per 100 gms. sat. sol.

At 16°
(Strömholm, 1903)

Solvent: 62.2 gms. S per liter sol'n. in CS₂
Sat. Sol.: 189.4 gms. I₂ per liter sat. sol.

At 10°, 18°
(Mori, 1923)

No evidence of the existence of compounds of iodine and sulfur.

The surface tensions and densities of solutions of sulfur, iodine, and selenium in carbon disulfide at 12°, 17°, and 25° have been accurately determined by Kapustinsky and Golutvin, 1947. The following systems were studied: S + CS₂, I + CS₂, S + I + CS₂, Se + I + CS₂, S + Se + CS₂ in solutions containing 0 - 0.05 gm. atoms of solute per liter.

SOLUBILITY OF IODINE IN VARIOUS INORGANIC SOLVENTS

In Titanium Tetrachloride (Negishi, Donnally and Hildebrand, 1933)			In Silicon Tetrachloride (Negishi, Donnally and Hildebrand, 1933)		
Gms. I per 100 gms. sat. sol.	Gm. Mols. I ₂ per 100 gm. sat. sol.		Gms. I per 100 gms. sat. sol.	Gm. Mols. I ₂ per 100 gm. sat. sol.	
t°			t°		
0.1	1.153	0.8633	0.1	0.2555	0.1713
25.0	2.855	2.150	25.0	0.7433	0.4987
40.0	5.631	3.499	40.0	1.309	0.8801
49.9	6.500	4.939	(determinations made in a nitrogen atmosphere)		

SOLUBILITY OF IODINE IN VARIOUS INORGANIC SOLVENTS--Cont.
(Quinn, 1928)

t°	d of CO ₂	Est. density of sat. sol.	Gm. I per 1 Gm. Mol. CO ₂	Gms. I per 100 gms. CO ₂
-21	1.031(-20°)	1.031 (-20°)	0.0102	0.0232
-11.4	0.981(-10°)	0.982 (-10°)	0.0191	0.0434
0	0.927	0.929	0.0347	0.0788
+10	0.858	0.863	0.0526	0.1195
20	0.770	0.775	0.0774	0.1759
25	0.710	0.720	0.0915	0.2079

SOLUBILITY OF IODINE IN ARSENIC TRICHLORIDE
(Sloan and Mallet, 1882; see also Montignie, 1941)

t°	0°	15°	96°
Gms. I per 100 gms. AsCl ₃	8.42	11.88	36.89

THE SYSTEM SbCl₃ - I₂
(Fialkov and Abarbarchuk, 1949)

mole%	m.pt.*	mole %	m.pt.*
SbCl ₃		SbCl ₃	
0.0	113.6	53.41	34.2
1.07	107.7	58.15	34.7
2.83	97.4	64.72	34.8
4.09	96.3	68.82	35.9
6.37	67.7	74.91	34.6
11.39	38.5	82.05	31.2
18.87	37.0	88.12	5.4
39.14	4.0*	95.91	-0.5
47.34	17.4	96.0	-2.0*
		100.0	+3.3

THE SYSTEM SbCl₃ - I₂
(Fialkov and Abarbarchuk, 1949)
[See also Montignie, 1941]

mole%	m.pt.*	mole %	m.pt.*
SbCl ₃		SbCl ₃	
0.0	113.6	51.76	78.5
9.39	101.6	56.79	76.6
16.59	98.7	66.73	64.1*
24.77	94.8	72.48	66.7
33.88	91.6	85.82	67.3
38.45	87.3	92.95	69.1
39.84	86.2	100.0	73.05
45.25	82.5		

* = Eutectic

MELTING POINTS OF IODINE WITH PHOSPHORUS HALIDES
(Fialkov and Kuzmenko, 1949)

PBr ₃ + I ₂				P ₂ I ₄ + I ₂			
Mole %	Melting	Mole %	Melting	Mole %	Melting	Mole %	Melting
PBr ₃	Point	PBr ₃	Point	P ₂ I ₄	Point	P ₂ I ₄	Point
0.0	113.2	67.9	65.4	0.0	113.3	27.1	46.5
12.6	103.7	73.3	58.7	1.1	111.5	31.5	38.0
21.3	97.2	77.8	52.2	4.7	104.2	34.3*	33.0
30.0	93.5	81.7	45.0	6.4	101.1	36.8	36.1
37.1	88.8	84.6	36.5	7.1	99.0	39.8	43.0
45.2	85.5	86.7	30.0	8.4	96.0	44.5	49.0
50.0	80.6	88.7	26.0	10.2	93.0	46.3	52.0
57.2	74.7	90.8	17.5	12.3	87.8	50.3	51.0
63.4	68.4	96.2	-5.0	14.3	83.4	58.5	79.5
				17.7	75.0	65.0	91.5
				20.1	69.0	67.4	99.0
				21.0	64.5		

*Eutectic

MELTING POINTS OF IODINE WITH PHOSPHORUS HALIDES—Cont.

PCl ₃ + I ₂		PCl ₅ + I ₂					
Mole % PCl ₃	Melting Point	Mole % PCl ₅	Melting Point	Mole % PCl ₅	Melting Point	Mole % PCl ₅	Melting Point
0.0	113.1	0.0	113.2	36.4	90.0	52.9	118.2
3.8	111.5	10.1	105.0	39.5	92.1	53.1	122.0
12.1	108.4	18.1	97.5	44.5	101.5	57.5	136.0
22.3	104.3	28.4	82.0	47.8	106.5	65.3	163.0
33.0	102.3	31.8	80.5	50.4	112.5	70.0	187.0
37.6	102.1	33.9	79.5*	52.2	116.5	74.0	198.0
58.8	102.1						

*Eutectic

THE SYSTEM PBr₅ - I₂
(Kuzmenko and Fialkov, 1949)

Mole % PBr ₅	Melting Point°	Mole % PBr ₅	Melting Point°	Mole % PBr ₅	Melting Point°	Mole % PBr ₅	Melting Point°
0.0	113.2	26.3	70.9	45.0	20.2	74.7	109.5
4.5	103.8	28.1	66.5	49.3	13.5	75.8	110.1
7.1	99.0	28.6	65.5	50.0	13.5*	78.2	108.2
10.6	93.0	30.4	63.0	50.4	13.5	80.2	110.0
14.2	87.0	33.2	56.0	53.1	17.5	84.3	108.0
14.9	85.0	36.3	48.0	57.9	39.0	89.0	110.5
20.1	81.5	37.6	38.5	65.7	94.0	90.0	109.4
22.1	79.5	40.5	32.0	69.1	105.0	100.0	103.7
26.2	71.0	41.2	28.2	72.4	107.0		

*Eutectic

Fusion-point data are given for the following mixtures:

- I + As (Jaeger and Doornbosch, 1912)
- I + CaI₂ (Olivari, 1908)
- I + HgI₂ (")
- I + In (Thiel and Koelsch, 1910)
- I + KI (Olivari, 1914; Briggs and Geigle, 1930; Fialkow and Kensmenke, 1936)
- I + LiI (Fialkow and Kensmenko, 1936)
- I + Ni(NH₃)₆I₂ (Fialkov and Sherchenko, 1950)
- I + S (Olivari, 1908; Boulouch, 1903; Smith and Carson, 1908)
- I + Sb (Jaeger and Doornbosch, 1912)
- I + Se (Pellini and Pedrina, 1908)
- I + Sn (Van Klooster, 1912-13; Reindars and Lange, 1912-13; Vasileu, 1916, 1917)
- I + Te (Jaeger and Menke, 1912; Demiens, 1921, 1923)
- I + Tl (Fialkow and Kenamenko, 1936)

I IODINE

SOLUBILITY OF IODINE IN GASES AND THE VAPORS OF SOLVENTS

Experimental determinations of the solubility of Iodine vapor in air are given by Baxter, 1907 and Baxter and Grose, 1915; in CO_2 and in H_2 by Braune and Strassmann, 1929; in air N_2 , O_2 , CH_4 , CO and the vapors of CHCl_3 , CS_2 , CCl_4 , Hexane and Ethyl Ether, by Brull and Ellerbrock, 1934.

Br IODINE MONOBROMIDE IBr

THE SYSTEM IBr - PBr_5 (Kuzmenko and Fialkov, 1951)				THE SYSTEM IBr - PBr_3 (Fialkov and Kuzmenko, 1949a)			
mole % PBr_5	f.pt.°	mole % PBr_5	f.pt.°	mole % PBr_3	f.pt.°	mole % PBr_3	f.pt.°
0.0	40.3	32.65	95.7	0.0	40.0	40.20	21.7
1.03	38.7	36.31	101.2	1.16	38.6	41.90	22.5
3.19	36.4	42.23	108.8	11.25	28.5	46.30	17.5
6.70	28.3	43.59	110.8	13.20	25.6	50.20	21.7
10.44	22.2	48.44	113.6	23.50	18.2	61.10	21.5
13.82	35.4	50.14	114.6	33.60	15.5*	74.90	34.1
14.09	34.3	52.05	114.4	35.03	21.8	87.20	39.5*
20.46	44.5	54.81	114.4				
27.60	86.5	57.56	114.4				

*Eutectic

The viscosities and conductivities in the systems IBr + KI and IBr + KBr were determined by Fialkov and Goldman, 1941.

The conductivities and other physical properties in the system IBr + KBr + Nitrobenzene were determined by Fialkov and Shor, 1949.

CN IODINE CYANIDE ICN

One liter sat. solution of iodine cyanide in water contains 0.2523 gm. mols. at 25°. (Yost and Stone, 1933).

DISTRIBUTION OF IODINE CYANIDE BETWEEN WATER AND CARBON TETRACHLORIDE AT 25° (Yost and Stone, 1933)

Gm. Mols. ICN per liter of:		$\frac{c}{w}$
H_2O layer (w)	CCl_4 layer (c)	
0.02480	0.004460	0.1798
0.03312	0.006007	0.1814
0.05144	0.009441	0.1835
0.06697	0.01239	0.1850
0.07960	0.01482	0.1862

IODINE MONOCHLORIDE ICl

CI

THE SYSTEM ICl - ACETIC ACID

(Cornog and Olsen, 1940)

No compounds or solid solutions are present.

t°	Mole % CH ₃ COOH	Solid Phase
27.3	0.0	ICl
26.0	4.9	"
25.0	7.3	"
23.0	12.8	"
20.0	17.8	"
19.0	19.6	"
17.0	24.0	"
15.0	26.7	"
10.0	34.3	"
0.1	42.1	"
-18.2	53.2	"
-35.5	60.0	ICl + CH ₃ COOH
-18.2	68.4	CH ₃ COOH
0.1	82.2	"
10.2	91.3	"
16.4	100.0	"

THE SYSTEM ICl - CARBON TETRACHLORIDE

(Cornog and Olsen, 1940)

Solid solutions are formed, and the liquidous is "S" shaped. A wholly metastable liquid miscibility gap occurs.

t°	Liquid Phase Mole % CCl ₄	Solid Phase Mole % CCl ₄
27.3	0.0	
26.0	2.0	
25.0	3.9	
23.1	..	0.85
23.0	9.4	
22.0	15.1	
21.0	24.3	
20.5	43.2	
20.0	54.0	
19.0	64.6	
18.8	..	4.1
17.0	73.2	
15.0	78.4	
10.2	..	15.3
10.0	85.2	
0.1	90.7	29.3
0.0	90.7	
-8.0	93.2	38.5
-15.7	95.3	
-25.5	98.7 Eutectic	
-26.4	98.2	
	Upper Liquid Layer	Lower Liquid Layer
0.0	76.2	15.3 } Meta-
10.0	65.6	29.5 } stable

THE SYSTEM ICl - PYRIDINE

(Fialkov and Muzyka, 1948)

The compounds C₅H₅N.ICl and C₅H₅N.2ICl are formed.

mole % C ₅ H ₅ N	t°	mole % C ₅ H ₅ N	t°	mole % C ₅ H ₅ N	t°	mole % C ₅ H ₅ N	t°
0.0	27.10	20.73	-6.30	33.56	34.80	71.54	80.10
1.27	25.06	23.89	+5.70	34.10	29.10	87.49	35.96
2.38	22.65	26.70	19.50	35.11	23.60*	92.84	8.60
4.59	18.00	25.09	13.09	36.31	28.15	96.02	36.20
6.66	16.20	28.82	23.50	39.49	68.50	98.90	48.10*
8.45	10.10	30.66	27.08	50.61	128.50	100.0	41.50
11.38	-9.15	33.31	35.10	62.62	105.20		

*Eutectic

I IODINE

THE SYSTEM ICl - ACETAMIDE (Fialkov and Muzyka, 1949)

[a 1:1 compound is formed]

mole % C ₆ H ₅ CONH ₂	t°	mole % C ₆ H ₅ CONH ₂	t°	mole % C ₆ H ₅ CONH ₂	t°	mole % C ₆ H ₅ CONH ₂	t°
0.0	27.15	31.74	16.50	53.20	27.85	63.66	50.30
2.69	21.00	38.92	27.90	53.49	26.55	74.72	79.10
7.10	9.30	46.25	35.65	56.32	24.98	85.60	99.50
9.48	7.10	50.00	36.90	..	23.3*	100.0	127.8
..	-23.5*			59.09	37.00		

cI *Eutectic

THE SYSTEM ICl - PCl₅ (Kuzmenko and Fialkov, 1951)

mole % PCl ₅	f.pt.*	mole % PCl ₅	f.pt.*
0.0	27.1	17.60	22.5
6.21	20.6	30.71	82.0
7.85	10.6	33.03	90.2
9.21	9.6	40.34	180.0

THE SYSTEM ICl - PCl₃ (Fialkov and Kuzmenko, 1949a)

mole % PCl ₃	f.pt.	mole % PCl ₃	f.pt.
0.0	27.2	13.9	38.0
2.7	24.5	14.8	37.0
7.5	81.0	20.3	94.6
13.4	36.8	36.0	109.5

THE SYSTEM ICl - KCl (Fialkov and Shor, 1949)

mole % KCl	f.pt.	mole % KCl	f.pt.
0.0	27.0	8.73	13.0
0.91	25.5	8.79	13.0
1.01	24.5	10.3	12.5
2.88	22.0	11.84	12.0
3.04	21.5	15.6	13.0
5.15	16.0		

THE SYSTEM ICl - AlCl₃ (Fialkov and Shor, 1949)

mole % AlCl ₃	f.pt.	mole % AlCl ₃	f.pt.
0.0	27.0	36.51	110
2.49	24.0	38.16	110
4.87	21.5	40.55	108
7.82	13.5	42.14	105*
10.59	7.0	46.56	132
13.31	2.0	51.61	138
13.98	5.0*	60.49	155
15.88	9.0	69.50	170
18.19	23.5	80.45	178
20.30	32.0	90.71	186
28.55	100.0		

*Eutectic

The following systems have been studied:

ICl + I Conductivity

ICl + AlBr₃

ICl + KBr

ICl + KI

ICl + KCl

ICl + AlCl₃

ICl + C₆H₅NO₂

ICl + C₆H₅NO₂ + KCl*

ICl + C₆H₅NO₂ + AlCl₃

" and Viscosity

" " "

" and Density

" " "

" and Transport numbers

" " "

" " "

Fialkov and Goldman (1941)

" " " "

" " " "

" " " "

Fialkov and Shor (1949a)

" " " "

Fialkov and Kazanaskaya
(1948)

*See also Fialkov and Kaganov, 1948.

IODINE PENTOXIDE I_2O_5 SOLUBILITY OF IODINE PENTOXIDE IN SULFURIC ACID AT 24°.77
(Lamb and Phillips, 1923)

Constant rotation in a thermostat was employed. Equilibrium was reached in some cases within one day, but with higher concentrations of sulfuric acid, there was a slow decrease from a definite initial solubility. This was studied over a period of 55 days and constancy was reached in all cases within 40 days.

Per cent conc. of H_2SO_4	Gms. I_2O_5 per liter		Per cent conc. of H_2SO_4	Gms. I_2O_5 per liter	
	Initial	Final		Initial	Final
50.0	54.79	54.79	89.0	22.1	15.1
60.0	34.68	34.68	90.3	22.7	14.5
75.0	19.48	19.48	92.0	23.4	13.5
78.0	18.66	18.66	96.0	(23.2)	11.0
79.6	19.0	18.5	98.0	(22.0)	9.5
82.0	19.9	18.8	99.9	..	3.48
84.6	20.5	19.3	102.0*	..	1.28
86.0	21.0	17.1	104.0	..	1.90
87.4	21.5	15.8	106.0	..	2.67

*This percentage represents weights of 100 % H_2SO_4 equivalent to 100 gm. of the acid in question. The 106.5 % of acid, therefore, contained 29.0 % of free SO_3 .

INDIUM In

SOLUBILITY OF INDIUM IN MERCURY
(Spicer and Banick, 1953)

The older data of Parks and Moran (1937) indicated a much lower solubility (1.23 wt.% at 0° to 1.31 wt.% at 50°). The present results agree with the qualitative observations of several other authors. The solid phase is probably a solid solution.

t°	Wt. % In in sat. sol.	t°	Wt. % In in sat. sol.	t°	Wt. % In in sat. sol.
10.3	54.92	78.1	69.84	121.7	84.07
37.6	60.01	94.2	74.70	135.1	90.12
59.2	64.84	108.2	79.30	151.3	97.46
				156.2	100.0

In INDIUM

THE SYSTEM INDIUM - GALLIUM
(Svirbely and Selis, 1954)

The data were calculated from the specific resistance of the various alloys. The solid phase rich in indium is a solid solution. The earlier data of de Boisbaudran (1885) and French, Saunders and Ingle (1938) are not in agreement.

Wt.% Ga	t°		Wt.% Ga	t°		Wt.% Ga	t°	
	Solidus	Liquidous		Solidus	Liquidous		Solidus	Liquidous
0.0	....	156.0	11.87	16.42	...	70.12	...	34.6
0.487	149.3	152.8	12.03	15.71	(eutec.)	74.98	...	16.3
2.000	139.2	142.7	12.21	15.75	(")	75.05	...	15.79
2.01	139.2	142.8	15.09	...	99.2	75.30	...	15.79
5.00	127.7	131.8	22.43	...	84.7	75.71	...	15.84
5.01	127.5	131.8	22.47	...	84.3	79.96	...	16.96
7.43	103.8	122.2	31.95	...	72.3	89.89	...	22.30
7.99	36.8	119.7	45.01	...	63.8	90.04	...	22.70
10.48	24.2	...	54.89	...	56.4	99.53	...	29.72
11.50	18.29	...	64.93	...	47.0	100.0	...	29.86

Melting points in the system $\text{In} + \text{In}_2\text{S}_3$ are given by Stubbs, Schufle, Thompson and Duncan (1952).

Br INDIUM BROMIDE InBr_3 SOLUBILITY IN WATER
(Ensslin, Ziemeck, and Schaepdryver, 1947)

t°	Gms. InBr_3 per 100 gms.		Solid Phase	t°	Gms. InBr_3 per 100 gms.		Solid Phase
	Sat. Sol.	Density t/20			Sat. Sol.	Density t/20	
0	71.26	2.3815	$\text{InBr}_3 \cdot 5\text{H}_2\text{O}$	25.5	85.10	2.8399	$\text{InBr}_3 \cdot 2\text{H}_2\text{O}$
2	71.66	2.3880	"	29	85.19	2.8562	"
4	72.53	2.3977	"	29.5	85.35	2.8569	"
14	74.51	2.4636	"	34.5	85.19	2.8734	InBr_3
16	75.62	2.4770	"	40	85.53	2.8742	"
18	76.71	2.5550	"	50	85.75	2.8988	"
19	79.94	2.6145	"	60	86.09	2.9026	"
20	80.55	2.6715	"	70	86.49	2.9027	"
22	84.64	2.8362	?	100	87.48	2.8932	"
22	85.26	2.8340	$\text{InBr}_3 \cdot 2\text{H}_2\text{O}$	105	87.91	2.8991	"
23	85.13	2.8348	"				

SOLUBILITY OF INDIUM BROMIDE IN HYDROBROMIC ACID SOLUTIONS AT 24°
(Ensslin and Dreyer, 1942)

Gms. per 100 gms. Sat. Sol.		Density	Solid Phase
InBr ₃	HBr		
84.27	0.0	2.836	InBr ₃
73.6	10.9	2.786	"
71.8	12.5	2.716	"

EQUILIBRIUM IN SOLUTIONS OF INDIUM BROMIDE AND OTHER BROMIDES
(Ensslin, Ziemeck, and Schaepdryver, 1947)

Br

The authors prepared various solutions and evaporated them at room temperature over phosphorous pentoxide. The crystals were separated from their saturated solutions, and both were analyzed.

Gms. Added Salt per 100 cc			Solid Phase	Gms. InBr ₃ per 100 cc			Solid Phase
Sat. Sol.				Sat. Sol.			
Sat. Sol.				Sat. Sol.			
With Magnesium Bromide				With Calcium Bromide			
165.3	31.1	MgBr ₂ .2InBr ₃ .7H ₂ O	184.8	17.0	CaBr ₂ .2InBr ₃ .8H ₂ O		
155.1	37.8	"	180.1	20.0	"		
92.7	61.1	MgBr ₂ .InBr ₃ .7H ₂ O	80.3	58.0	CaBr ₂ .InBr ₃ .8H ₂ O		
85.9	62.8	"	76.9	76.5	"		
77.8	65.9	"	61.8	78.0	"		
76.6	67.4	"	53.4	82.2	"		
63.9	74.7	MgBr ₂ .6H ₂ O	47.3	83.4	3CaBr ₂ .2InBr ₃ .23H ₂ O		
44.9	83.0	"	39.8	85.3	"		
			29.0	90.8	2CaBr ₂ .InBr ₃ .14H ₂ O		
			26.4	93.8	"		
With Strontium Bromide				With Lithium Bromide			
179.5	14.1	SrBr ₂ .2InBr ₃ .9H ₂ O					
165.3	28.2	"					
162.5	29.4	"	71.7	65.1	3LiBr.InBr ₃ .8H ₂ O		
159.1	29.5	"	59.3	73.8	"		
149.8	37.8	"	14.2	93.9	"		
141.2	40.1	"					
140.0	42.4	SrBr ₂ .InBr ₃ .10H ₂ O					
126.0	45.7	"					
124.8	47.2	2SrBr ₂ .InBr ₃ .16H ₂ O	176	0.42	TlBr.InBr ₃ .3H ₂ O		
105.3		SrBr ₂ .aq.	243	0.52			
With Zinc Bromide				With Barium Bromide			
102.9	127.8	3ZnBr ₂ .4InBr ₃ .14H ₂ O	There are no double salts formed in the				
87.7	140.2	"	system InBr ₃ + BaBr ₂ + H ₂ O				
64.9	164.6	"					
56.2	175.0	3ZnBr ₂ .InBr ₃ .4H ₂ O					

SOLUBILITY OF INDIUM BROMIDE IN ORGANIC SOLVENTS AT 20°
(Ensslin and Lessmann, 1947)

	Gms. InBr ₃ per 100 gms.				Gms. InBr ₃ per 100 gms.		
	Solvent	Sat. Sol.	Density	Solvent	Sat. Sol.	Density	
Br	Benzene	0.48	0.883	Chloroform	3.10	1.497	
	1,2 Dichlorethylene	2.31	1.269	Methyl Alcohol	74.08	2.014	
	Ethylene Glycol	61.59	2.137	Ethyl Alcohol	73.31	2.215	
	Glycerin	7.00	1.205	Amyl Alcohol	49.37	1.352	
	Ethyl Acetate	60.00	1.680	Acetone	72.33	1.902	
	Amyl Acetate	56.16	1.550	Ether	71.44	1.807	

Not soluble in petroleum ether or carbon tetrachloride.

100 gms. of a saturated solution of indium bromide in alcohol contains 163.9 gms. InBr₃ at 20° (density = 2.215). The solid phase is InBr₃. (Ensslin and Dreyer, 1942).

The extraction of indium by methyl isobutyl ketone and by ethyl ether from solutions containing HBr, K and Na salts, and excess Br⁻ ion were studied in detail at both tracer and macro concentrations by Irving and Rossotti (1955). Additional data are given for extraction by methyl propyl ketone, methyl isopropyl ketone, methyl isobutyl ketone, furfuraldehyde, ethyl acetate, and ethyl ether showing that they decrease in efficiency in the order given. The effect of HBr vs. HCl or HI was determined. Benzene, toluene, xylene, hexane, cyclohexane and carbon disulfide extracted indium very poorly.

CH INDIUM OXIDE In(C₉H₆NO)₃ [8-Hydroxy Quinolate]

The solubility product $K = [\text{In}^{+3}] [\text{C}_9\text{H}_6\text{NO}^-]^3$ at 18° is $K = 2 \times 10^{-37}$.

One liter of a saturated solution of In(C₉H₆NO)₃ in chloroform at 18° contains 0.24 moles. - LaCroix, 1947.

Data for the extraction of indium (sulfate) by chloroform from solutions containing 8-hydroxy quinoline at different pH are given by Moeller, 1943a.

CN INDIUM FERROCYANIDE In₃[Fe(CN)₆]₄

A saturated solution in water contains 2.3×10^{-6} gm. ions of In⁺³ per liter. (Tananaev, Glushkova and Seifer, 1956).

CI INDIUM CHLORIDE InCl₃

SOLUBILITY OF INDIUM CHLORIDE IN WATER
(Ensslin, Ziemeck, and Schaepdryver, 1947)

t°	Gms. InCl ₃ per 100 gms. Sat. Sol.	Density t ₂₀	Solid Phase
2	62.50	1.8500	InCl ₃ ·4H ₂ O
14.5	65.44	1.9420	"
22	66.11 (64.7)*	1.9736	"

*At 22°, 100 gms. of a saturated solution in water contain 64.7 gms. InCl₃ (density = 1.960; Solid Phase InCl₃·4H₂O.) (Cont.)

SOLUBILITY OF INDIUM CHLORIDE IN WATER--Cont.

t°	Gms. InCl ₃ per 100 gms. Sat. Sol.	Density t_{20}	Solid Phase
24	67.92	2.0192	InCl ₃ .4H ₂ O
26	69.62	2.0333	"
31	71.12	2.0828	"
35	73.07	2.1166	"
30.5	69.85	2.0592	InCl ₃ .3H ₂ O
41	71.7	2.085	"
51	73.31	2.1702	"
60	75.34	2.2000	"
70	77.71	2.2278	"
75	78.3	2.233	"
80	78.87	2.2506	InCl ₃ .2.5H ₂ O
81	78.79	2.2549	"
85	79.23	2.2603	"
90	79.50	2.2662	"
94	80.27	2.2768	"
98	80.74	2.2834	"
105	81.33	2.2935	InCl ₃ .2H ₂ O
110	81.35	2.2942	"
118	81.68	2.3069	"

At 22°, 100 gms. of a saturated solution in 3% HCl contain 59.5 gms. InCl₃. (Esselin and Dreyer, 1942).

EQUILIBRIUM IN SOLUTIONS OF INDIUM CHLORIDE WITH OTHER CHLORIDES
(Esselin, Ziemeck, and Schaepdryver, 1947)

The authors prepared various solutions and evaporated them at room temperature over phosphorous pentoxide. The crystals were separated from the saturated solutions, and both were analyzed.

Gms. per 100 cc Sat. Sol.			Gms. per 100 cc Sat. Sol.		
Added		Solid Phase	Added		Solid Phase
InCl ₃	Salt		InCl ₃	Salt	
<u>With Magnesium Chloride</u>			<u>With Strontium Chloride</u>		
131.8	13.3	MgCl ₂ .2InCl ₃ .10H ₂ O	134.9	19.2	SrCl ₂ .2InCl ₃ .8H ₂ O
112.0	18.0	"	110.6	25.8	SrCl ₂ .InCl ₃ .6H ₂ O
109.0	22.7	MgCl ₂ .InCl ₃ .7H ₂ O	104.5	26.5	"
73.4	36.4	"	104.0	28.0	"
64.6	38.0	"	96.3	28.9	"
53.0	43.1	2MgCl ₂ .InCl ₃ .2H ₂ O	74.6	36.7	"
51.6	44.0	"	74.2	37.1	SrCl ₂ .6H ₂ O
50.1	46.9	"			
<u>With Calcium Chloride</u>			<u>With Lithium Chloride</u>		
143.9	8.4	InCl ₃ .4H ₂ O	133.3	14.9	Hydrated <u>LiCl</u>
135.3	10.8	CaCl ₂ .2InCl ₃ .12H ₂ O			Solid Solution InCl ₃ =
127.6	13.6	3CaCl ₂ .4InCl ₃ .30H ₂ O	127.0	15.3	" =
93.4	30.6	CaCl ₂ .InCl ₃ .8H ₂ O	114.5	17.9	" =
64.3	45.8	"	106.9	16.1	" =

(Cont.)

(Cont.)

IN INDIUM

EQUILIBRIUM IN SOLUTIONS OF INDIUM CHLORIDE WITH OTHER CHLORIDES—Cont.

Gms. per 100 cc Sat. Sol.			Gms. per 100 cc Sat. Sol.		
Added		Solid Phase	Added		Solid Phase
InCl ₃	Salt		InCl ₃	Salt	
With Calcium Chloride—Cont.					
54.3	54.5	CaCl ₂ .InCl ₃ .8H ₂ O	101.4	22.7	Hydrated <u>LiCl</u>
42.4	60.1	"			Solid Solution InCl ₃ =
36.2	67.3	"			2.43
With Lithium Chloride—Cont.					
			100.6	23.6	"
			89.8	18.9	3LiCl.InCl ₃ .9H ₂ O
			24.9	46.7	"
			20.0	51.7	"
			12.9	55.7	"
			9.6	58.6	LiCl
			8.7	58.4	"
With Zinc Chloride					
54.9	115.5	ZnCl ₂ .2InCl ₃ .8H ₂ O			
48.2	125	2ZnCl ₂ .InCl ₃ .5H ₂ O			

Cl

The compound $\text{InCl}_3 \cdot \text{TlCl} \cdot 3\text{H}_2\text{O}$ is formed with Thallium Chloride, and no double salts are formed in the system $\text{InCl}_3 + \text{BaCl}_2 + \text{H}_2\text{O}$. The compound $3\text{LiCl} \cdot \text{In}_2\text{S}_3$ was prepared from solutions of the salts.

Data for the systems $\text{InCl}_3 + \text{Li}_4\text{Fe}(\text{CN})_6 + \text{H}_2\text{O}$
 $\text{InCl}_3 + \text{Na}_4\text{Fe}(\text{CN})_6 + \text{H}_2\text{O}$
 $\text{InCl}_3 + \text{K}_4\text{Fe}(\text{CN})_6 + \text{H}_2\text{O}$
 are given by Deichman and Tananaev, 1955.

SOLUBILITY OF INDIUM CHLORIDE IN ORGANIC SOLVENTS AT 20° (Ensslin and Lessmann, 1947)

Solvent	Gms. InCl ₃ per 100 gms.		Solvent	Gms. InCl ₃ per 100 gms.	
	Sat.	Sol. Density		Sat.	Sol. Density
Chloroform	1.52	1.517	Glycerin	1.57	1.220
Methyl Alcohol	51.16	1.406	Ethyl Acetate	38.25	1.247
	(53.2, 22°)	(1.400)	Amyl Acetate	26.20	1.084
Ethyl Alcohol	36.20	1.16	Acetone	37.97	1.142
Amyl Alcohol	23.02	0.996	Ether	35.18	0.967
Ethylene Glycol	25.17	1.495			

Not soluble in petroleum ether, benzene, 1,2 dichlorethylene, or carbon tetrachloride.

Melting points in the systems $\text{InCl}_3 + \text{AgCl}$, $\text{InCl}_3 + \text{CdCl}_2$, $\text{InCl}_3 + \text{NaCl}$, $\text{InCl}_3 + \text{PbCl}_2$, and $\text{InCl}_3 + \text{ZnCl}_2$ are given by Vovkogon and Fialkov, (1945).

INDIUM Cobalt Hexamine CHLORIDE $[\text{Co}(\text{NH}_3)_6]\text{InCl}_6$

One liter of sat. soln. in water at 20° contains 10.1 gms. $[\text{Co}(\text{NH}_3)_6]\text{InCl}_6$
 " " " " " 5% NH_4Cl " " 0.11 " "
 " " " " " 1% HCl " " 0.067 " "
 - Ensslin and Dreyer, 1942

INDIUM FLUORIDE InF_3

F

SOLUBILITY IN WATER

At 22°, 7.83 gms. InF_3 are contained in 100 gms. of saturated solution in water (density = 1.070: solid phase $\text{InF}_3 \cdot 3\text{H}_2\text{O}$) (Ensslin and Dreyer, 1942).

At 25°, 8.64 gms. of InF_3 are contained in 100 ml. of saturated solution in water. (Thiel, 1904).

SOLUBILITY OF INDIUM FLUORIDE IN ORGANIC SOLVENTS AT 20°
(Ensslin and Lessmann, 1947)

Solvent	Gms. InF_3 per 100 gms.		Density	Solvent	Gms. InF_3 per 100 gms.		Density
	Sat.	Sol.			Sat.	Sol.	
Methyl Alcohol	0.89		0.813	Glycerin	0.03		1.223
Ethyl Alcohol	.02		.825	Ethyl Acetate	.02		0.914
Amyl Alcohol	.006		.810	Amyl Acetate	.005		0.870
Ethylene Glycol	.27		1.15	Acetone	Trace		...

Not soluble in petroleum ether, benzene, chloroform, carbon tetrachloride, 1,2 dichlorethylene, or ether.

INDIUM Sodium FLUORIDE Na_3InF_6

At 23°, 100 gms. of a saturated solution in water contain 8.33 gms. Na_3InF_6 (density = 1.0175). (Ensslin and Dreyer, 1942).

INDIUM IODIDE InI_3 SOLUBILITY OF INDIUM IODIDE IN WATER
(Ensslin, Ziemeck, and Schaepdryver, 1947)

The solid phase was anhydrous InI_3 throughout. The results do not lie on a smooth curve.

t°	Gms. InI_3 per 100 gms.		Density	t°	Gms. InI_3 per 100 gms.		Density
	Sat.	Sol.			Sat.	Sol.	
1	92.31		3.4492	40	94.32		3.4809
4.5	92.35		3.4503	51	94.24		3.4982
7	92.40		3.4522	61	94.48		3.5064
22	92.91		3.4620	69	94.81		3.5273
30	93.51		3.4687	70	95.29		3.5299

SOLUBILITY OF INDIUM IODIDE IN HYDRIODIC ACID SOLUTIONS
(Temperature not given)
(Ensslin and Dreyer, 1942)

Gms. per 100 gms. sat. sol.		Density	Solid Phase
InI ₃	HI		
91.6	0	3.438	InI ₃
87.2	2.1	3.398	"
80.6	4.7	3.026	"

EQUILIBRIUM IN SOLUTIONS OF INDIUM IODIDE AND OTHER IODIDES
(Ensslin, Ziemeck, and Schaepdryver, 1947)

The authors prepared various solutions and evaporated them at room temperature over phosphorous pentoxide. The crystals were separated from their saturated solutions and both were analyzed.

Gms.			Gms.		
InI ₃ per		Solid Phase	InI ₃ per		Solid Phase
100 cc	Salt per 100 cc		100 cc	Salt per 100 cc	
Sat. Sol.	Sat. Sol.		Sat. Sol.	Sat. Sol.	
With Magnesium Iodide					
81.6	68.6	MgI ₂ .2InI ₃ .11H ₂ O	124.3	69.7	CaI ₂ .InI ₃ .8H ₂ O
70.8	75.0	3MgI ₂ .4InI ₃ .26H ₂ O	22.5	107.1	"
22.5	89.0	MgI ₂ .InI ₃ .6H ₂ O	10.9	112.2	2CaI ₂ .3InI ₃ .13H ₂ O
20.0	96.1	"	3.8	117.9	CaI ₂ .InI ₃ .6H ₂ O
11.4	107.1	"	3.2	124.7	CaI ₂ .aq.
9.7	106.4	MgI ₂ .6H ₂ O	1.6	131.5	"
6.4	107.5	"			
5.1	113.8	"			
3.4	116.7	"			
With Calcium Iodide					
			230.1	22.3	InI ₃
			193.0	34.2	BaI ₂ .2InI ₃ .10H ₂ O
			188.7	40.4	"
120.9	74.8	SrI ₂ .InI ₃ .10H ₂ O	174.0	48.0	BaI ₂ .InI ₃ .5H ₂ O
102.3	79.3	"	100.0	81.2	"
95.0	80.6	"	134.3	71.2	BaI ₂ .aq.
93.2	81.0	"	132.6	73.2	"
59.1	96.2	"			
13.0	115.7	"			
9.5	118.8	2SrI ₂ .InI ₃ .18H ₂ O			
8.9	128.7	SrI ₂ .aq.	99.3	113.3	2ZnI ₂ .3InI ₃ .13H ₂ O
With Strontium Iodide					
			63.0	168.9	"
			39.7	180.6	ZnI ₂ .3InI ₃ .5H ₂ O
			33.5	191.3	"
123.0	48.2	LiI.InI ₃ .4H ₂ O	23.9	208.0	"
60.9	68.7	"	28.5	218.7	ZnI ₂ .aq.
12.5	90.6	"	26.4	221.8	"
With Lithium Iodide					
With Zinc Iodide					
With Barium Iodide					
With Thallium Iodide					
10.3	0.1	TlI.2InI ₃ .3H ₂ O			
28.0	0.61	"			

SOLUBILITY OF INDIUM IODIDE IN ORGANIC SOLVENTS AT 20°
(Ensslin and Lessmann, 1947)

Solvent	Gms. InI ₃ per 100 gms. Sat. Sol.	Density
Petroleum Ether	0.41	0.723
Benzene	6.27	0.929
Chloroform	8.98	1.558
Carbon Tetrachloride-Decomposes	...	...
1,2 Dichlorethylene	5.33	1.313
Methyl Alcohol	86.64	2.706
Ethyl Alcohol	84.37	2.687
Amyl Alcohol	58.29	1.566
Ethylene Glycol	72.77	2.4603
Glycerin	10.85	1.249
Ethyl Acetate	78.35	2.351
Amyl Acetate	73.75	2.096
Acetone	74.94	2.288
Ether	85.50	2.248

INDIUM IODATE In(IO₃)₃

10

SOLUBILITY OF INDIUM IODATE IN NITRIC ACID SOLUTIONS AT 20°
(Ensslin, 1942-3)

Gms. HNO ₃ per Liter of Sat. Sol.	Gms. In(IO ₃) ₃ per Liter of Sat. Sol.	Density	Gms. HNO ₃ per Liter of Sat. Sol.	Gms. In(IO ₃) ₃ per Liter of Sat. Sol.	Density
0.0	0.53 (0.67)*	1.000	376	14.69	1.200
84	7.80	1.048	515	11.10	1.329
142	10.90	1.080	704	6.02	1.329
278	15.99	1.158	900	0.72	1.396
300	16.89	1.167			

*(Mathers and Schluederberg, 1908).

INDIUM per IODATE InIO₅

10

Ensslin, Ziemeck, and Schaepdryver, 1947 report the preparation of the following compounds:

Gms. per 100 gms.
Saturated Solution

InIO ₅	In(NO ₃) ₃	HNO ₃	Density	Solid Phase
2.75	3.02	36.7	1.413	3InIO ₅ .In(OH) ₃
6.80	6.25	29.9	1.391	"
0.85	27.3	36.5	1.600	3InIO ₅ .HIO ₄
1.13gIn	23.3gIO ₄	10.4gSO ₄	1.375	4InIO ₅ .In(OH) ₃ .5H ₂ O

IN INDIUM

OH INDIUM HYDROXIDE $\text{In}(\text{OH})_3$

SOLUBILITY IN WATER (Moeller, 1941)

From titrations of indium sulfate, nitrate, and chloride solutions with sodium, potassium, and ammonium hydroxide solutions, the following results were obtained.

t°	K_{sp}	Gm. moles $\text{In}(\text{OH})_3$ per liter
10	0.04×10^{-32}	1.1×10^{-9}
25	0.7×10^{-32}	2.3×10^{-9}
40	2.4×10^{-32}	3.0×10^{-9}

The salts were all assumed to be 100% dissociated, and slightly larger values were obtained from InCl_3 solutions than from the other two salts.

Oka, 1940 found the solubility of indium hydroxide in water to be 2.2×10^{-9} moles per liter.

Data for the system $\text{In}_2\text{O}_3 - \text{H}_2\text{O}$ from $25^\circ - 800^\circ$, 500 - 20,000 p.s.i. are given by Roy and Shafer, 1954.

S INDIUM SULFIDE In_2S_3

Enslein, Ziemeck, and Schaepdryver, 1947 report the preparation of the following compounds:

$\text{NaInS}_2 \cdot 4\text{H}_2\text{O}$ from a saturated solution containing: 3.7 gms. Na_2S and 0.84 gms. In_2S_3 per 100 cc.

$\text{NaInS}_2 \cdot 3\text{H}_2\text{O}$ from a more concentrated solution.

$\text{KInS}_2 \cdot 4\text{H}_2\text{O}$ from a saturated solution containing 0.26 g In_2S_3 per 100 cc.

$\text{LiInS}_2 \cdot \text{LiOH} \cdot 9\text{H}_2\text{O}$ from a saturated solution containing 2.7 gms. In_2S_3 per 100 cc.

$4\text{LiInS}_2 \cdot 4\text{LiOH} \cdot \text{LiCl} \cdot 10\text{H}_2\text{O}$ from a saturated solution containing 1.8 g In_2S_3 , 22.8 g Li_2S , and 32.5 g LiCl per 100 cc.

$\text{LiInS}_2 \cdot \text{LiOH} \cdot 2\text{LiCl}$ from a saturated solution containing 0.55 g In_2S_3 , 40 g Li_2S , and 63.5 g LiCl per 100 cc.

$3\text{LiCl} \cdot \text{In}_2\text{S}_3$ from a saturated solution containing 0.048 gms. In_2S_3 and 27.3 g LiCl in 100 cc.

$3\text{BaS} \cdot \text{Ba}(\text{OH})_2 \cdot 3\text{In}_2\text{S}_3 \cdot 16\text{H}_2\text{O}$ from a saturated solution containing 2.7 g BaCl_2 and 2.2 g BaS in 100 cc.

SO INDIUM SULFATE $\text{In}_2(\text{SO}_4)_3$

SOLUBILITY OF INDIUM SULFATE IN SULFURIC ACID SOLUTIONS (Enslein, Lessmann, and Ziemeck, 1947)

Each solution was analyzed for indium and for sulfate, and the amount of sulfuric acid present was calculated from the amount of sulfate in excess of that required to form $\text{In}_2(\text{SO}_4)_3$. In neutral or very

SOLUBILITY OF IRIUM SULFATE IN SULFURIC ACID SOLUTIONS—Cont.

weakly acid solutions, the solid phase is the basic salt $2\text{In}(\text{OH})\text{SO}_4 \cdot 5\text{H}_2\text{O}$.

A diagram showing the freezing point lowering of $\text{In}_2(\text{SO}_4)_3$ in H_2SO_4 solutions is given by Muzyka, 1953.

Gms. per 100 gms. sat. sol.			Gms. per 100 gms. sat. sol.					
H_2SO_4	$\text{In}_2(\text{SO}_4)_3$	Density	Solid Phase	H_2SO_4	$\text{In}_2(\text{SO}_4)_3$	Density	Solid Phase	
Results at 20°				Results at 40°—Cont.				
3.6	51.19	1.754	$\text{In}_2(\text{SO}_4)_3 \cdot 10\text{H}_2\text{O}$	26.9	23.22	1.510	$\text{In}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$	
6.6	45.05	1.678	"	29.9	20.55	1.492	"	
7.5	43.95	1.657	"	32.0	18.24	1.486	"	
9.4	41.88	1.642	"	33.6	15.60	1.466	"	SO
10.3	40.81	1.637	"	36.6	12.11	1.433	"	
13.7	36.53	1.620	"	37.2	10.85	1.429	" + 1:1:7	
15.3	34.70	1.598	"	41.0	9.02	1.422	$\text{In}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$	
20.2	30.44	1.551	"	42.6	7.46	1.422	"	
21.0	29.77	1.545	"	44.7	5.86	1.407	"	
24.3	26.38	1.524	"	46.6	3.95	1.417	"	
25.3	24.80	1.521	"	50.8	1.80	1.417	"	
27.8	21.92	1.516	" + $\text{In}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$	53.7	0.74	1.450	"	
28.2	21.58	1.512	$\text{In}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$	57.0	0.36	1.476	"	
30.8	18.94	1.480	"	62.2	0.21	1.533	"	
33.2	15.47	1.453	"	Results at 60°				
37.8	11.39	1.446	"	2.9	54.80	1.772	$\text{In}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$	
41.3	6.51	1.424	"	2.8	54.12	1.769	"	
46.6	3.52	1.400	"	5.2	51.87	1.740	"	
49.7	1.75	1.417	"	9.5	46.23	1.678	"	
51.7	0.85	1.435	"	10.6	44.56	1.667	"	
53.4	0.75	1.444	"	11.8	43.97	1.655	"	
54.9	0.55	1.450	"	13.0	41.27	1.650	"	
90.2	0.061	1.820	"	14.2	39.24	1.645	"	
Results at 40°				16.6	36.31	1.610	"	
4.15	53.44	1.735	$\text{In}_2(\text{SO}_4)_3 \cdot 10\text{H}_2\text{O}$	18.4	34.05	1.587	"	
5.9	51.64	1.720	"	22.5	28.86	1.533	"	
7.5	49.38	1.693	"	27.5	22.26	1.490	"	
8.5	47.81	1.690	"	30.6	18.42	1.456	"	
9.6	46.27	1.680	$\text{In}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$	33.8	16.32	1.451	"	
10.5	45.84	1.678	$\text{In}_2(\text{SO}_4)_3 \cdot 10\text{H}_2\text{O}$	36.7	12.65	1.426	"	
12.2	42.84	1.660	$\text{In}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$	38.7	8.24	1.417	"	
14.1	40.59	1.631	"	43.5	6.72	1.410	"	
15.1	39.24	1.621	"	50.6	2.86	1.420	"	
17.0	36.53	1.614	"	52.8	2.05	1.432	"	
18.7	34.05	1.604	"	54.4	1.62	1.447	$\text{In}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$	
20.5	32.20	1.580	"	60.6	0.61	1.513	"	
21.3	30.67	1.562	"	68.0	0.37	1.598	"	
23.4	27.51	1.555	"	84.4	0.13	1.780	"	

IRIDIUM AMMONIUM SULFATE (alum) in $(\text{NH}_4)_2(\text{SO}_4) \cdot 24\text{H}_2\text{O}$

100 gms. H_2O dissolve 200 gms. of the salt at 16° and 500 gms. at 30°. (Rossler, 1873).

IRIDIUM Ir

Noddock, Noddack, and Bohnstedt (1940) found that metallic iridium was concentrated in the iron phase in the system $\text{Fe} + \text{FeS}$ at the eutectic temperature of the system.

Ir Iridium

IRIDIUM AMMINES

SOLUBILITY IN WATER
(Palmaer, 1891)

Double Salt	Formula	t°	Gms. per 100 Gms. H ₂ O
Irido Pentammine Bromide	$\text{Ir}(\text{NH}_3)_5\text{Br}_3$	12.5	0.284
" " Bromonitrate	$\text{Ir}(\text{NH}_3)_5\text{Br}(\text{NO}_3)_2$	18	5.58
" " Tri Chloride	$\text{Ir}(\text{NH}_3)_5\text{Cl}_3$	15.1	6.53
" " Chloro Bromide	$\text{Ir}(\text{NH}_3)_5\text{ClBr}_2$	20	0.665* } ?
" " Chloro Iodide	$\text{Ir}(\text{NH}_3)_5\text{ClI}_2$	15	0.47
" " Chloro Nitrate	$\text{Ir}(\text{NH}_3)_5\text{Cl}(\text{NO}_3)_2$	20	0.47*
" " Chloro Sulphate	$\text{Ir}(\text{NH}_3)_5\text{ClSO}_4 \cdot 2\text{H}_2\text{O}$	15.0	0.95
" " Nitrate	$\text{Ir}(\text{NH}_3)_5(\text{NO}_3)_2$	16	1.94
" " Aquo Pentammine Bromide	$\text{Ir}(\text{NH}_3)_5(\text{H}_2\text{O})\text{Br}_3$	ord. temp.	1.93*
" " Chloride	$\text{Ir}(\text{NH}_3)_5(\text{H}_2\text{O})\text{Cl}_3$	ord. temp.	0.74
" " Nitrate	$\text{Ir}(\text{NH}_3)_5(\text{H}_2\text{O})(\text{NO}_3)_2$	17	0.28
			25.0
			74.7
			10.0

*gms. per 100 cc. sat. sol. - Yatmirskaia, 1950.

Br Iridium Organic Bromides and Chlorides

Cl

SOLUBILITY OF EACH IN WATER AT 20°
(Benrath, 1924)

Compound	Formula	Gms. compd. per 100 cc. H ₂ O	Gms. mols. compd. per liter sat. sol.
Mono quinine	hexa chlor iridate $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrCl}_6$	0.0439	$6.0 \cdot 10^{-4}$
" " " "	" brom " $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrBr}_6$	0.0174	$1.7 \cdot 10^{-4}$
Di quinine	" chlor " $(\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0012	$1.2 \cdot 10^{-3}$
Mono cinchonine	" " " $\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrCl}_6$	0.0163	$1.8 \cdot 10^{-3}$
" " " "	" brom " $\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrBr}_6$	0.0062	$6.5 \cdot 10^{-3}$
Di cinchonine	" chlor " $(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0037	$3.5 \cdot 10^{-3}$
Mono cinchonidine	" " " $\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrCl}_6$	0.0277	$3.9 \cdot 10^{-4}$
" " " "	" brom " $\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2 \cdot \text{H}_2\text{IrBr}_6$	0.0048	$5.0 \cdot 10^{-3}$
Di cinchonidine	" chlor " $(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}_2)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0034	$3.4 \cdot 10^{-3}$
Strychnine	" " " $(\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0045	$4.3 \cdot 10^{-3}$
" " " "	" brom " $(\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2)_2 \cdot \text{H}_2\text{IrBr}_6$	0.0015	$1.2 \cdot 10^{-3}$
Brucine	" chlor " $(\text{C}_{23}\text{H}_{26}\text{N}_2\text{O}_4)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0083	$7.0 \cdot 10^{-3}$
" " " "	" brom " $(\text{C}_{23}\text{H}_{26}\text{N}_2\text{O}_4)_2 \cdot \text{H}_2\text{IrBr}_6$	0.0015	$1.2 \cdot 10^{-3}$
Nitron	" chlor " $(\text{C}_{20}\text{H}_{16}\text{N}_4)_2 \cdot \text{H}_2\text{IrCl}_6$	0.0082	$8.0 \cdot 10^{-3}$
" " " "	" brom " $(\text{C}_{20}\text{H}_{16}\text{N}_4)_2 \cdot \text{H}_2\text{IrBr}_6$	0.0086	$1.2 \cdot 10^{-3}$

Cl Iridium (IV) Chloride IrCl_4

When 1 gm. iridium as chloride is dissolved in 100 cc. of 10% HCl and shaken at 18° with 100 cc. of ether, 0.02 per cent of the metal enters the ethereal layer. When 20% HCl is used 5% of the metal enters the ether. When dissolved in 1% HCl or in water approximately 0.01 per cent of the metal enters the ethereal layer. (Mylius, 1911).

IRIDIUM (IV and III) POTASSIUM CHLORIDE K_2IrCl_6, K_2IrCl_5

100 gms. H_2O dissolve 1.25 gms. K_2IrCl_6 at 18-20°.

100 gms. H_2O dissolve 9.18 gms. dipotassium aquo penta chloroiridite, $K_2IrCl_5(H_2O)$ at 19°. (Delepine, 1908).

IRIDIUM (III) AMMONIUM CHLORIDE $(NH_4)_3IrCl_6$

100 gms. H_2O dissolve 10.5 gms. of the (hydrated?) salt at 19°. (Delepine, 1908).

IRIDIUM (IV) AMMONIUM CHLORIDE $(NH_4)_2IrCl_6$

Cl

SOLUBILITY IN WATER

The various data are not in good agreement

Results of Archibald and Kern, 1917				Results of Rimbach and Kern, 1907	
Gms. $(NH_4)_2IrCl_6$ per 100 gms. H_2O		Gms. $(NH_4)_2IrCl_6$ per 100 gms. H_2O		Gms. $(NH_4)_2IrCl_6$ per 100 gms. H_2O	
t°		t°		t°	
0.4	0.5561	30	1.2066	14.4	0.699
10	0.7055	40	1.5665	26.8	0.905
18	1.086*	50	1.9664	39.4	1.226
19	0.77	60	2.4567	52.2	1.608
25	1.0910	80**	4.3815	61.2	2.130
				69.3	2.824

*Ogawa, 1930.

Delepine, 1908.

**The salt decomposes at higher temperatures.

SOLUBILITY OF IRIDIUM AMMONIUM CHLORIDE IN AQUEOUS SOLUTIONS OF
AMMONIUM CHLORIDE AT 20°
(Archibald and Kern, 1917)

Gm. mols. NH_4Cl per liter	Gms. $(NH_4)_2IrCl_6$ per 100 gms. solvent	Gm. mols. NH_4Cl per liter	Gms. $(NH_4)_2IrCl_6$ per 100 gms. solvent
0.10	0.1793	1.00	0.0064
0.20	0.0780	2.00	0.0027

IR IRIIDIUM

THE SYSTEM IRIIDIUM AMMONIUM CHLORIDE - PLATINUM AMMONIUM CHLORIDE - WATER AT 18° (Ogawa, 1930)

Gms. per 100 gms. sat. solution		Gms. per 100 gms. sat. solution	
Ir(NH ₄) ₂ Cl ₆	Pt(NH ₄) ₂ Cl ₆	Ir(NH ₄) ₂ Cl ₆	Pt(NH ₄) ₂ Cl ₆
1.086	0.0	0.424	0.364
1.016	0.089	0.258	0.481
0.902	0.196	0.197	0.594
0.605	0.267	0.105	0.605
0.524	0.288	0.0	0.768

CI Aquo IRIIDIUM (IV) AMMONIUM CHLORIDE (NH₄)₂IrCl₅(H₂O)

At 19°, 100 gms. H₂O dissolve 15.4 gms. (NH₄)₂IrCl₅(H₂O).
(Delepine, 1908).

IRIDIUM (IV) SODIUM CHLORIDE Na₂IrCl₆

(Ogawa, 1930)
Solid Phase Na₂IrCl₆·12H₂O

t°	Gms. IrNa ₂ Cl ₆ per 100 gms. H ₂ O	t°	Gms. IrNa ₂ Cl ₆ per 100 gms. H ₂ O	t°	Gms. IrNa ₂ Cl ₆ per 100 gms. H ₂ O
15	34.46	40	96.00	63	202.63
22	41.39	45	123.96	70	231.66
25	46.11	51	155.26	75	253.17
30	56.17	55	169.27	80	279.34
35	74.03	60	191.18	85	307.26

O IRIIDIUM OXIDE IrO₂·xH₂O

One liter of water sat. with Iridium Oxide contains 0.002 gm. IrO₂
at 20°.

One liter of 0.002 N HCl sat. with Iridium Oxide contains 0.0005
gm. IO₂ at 20°. (Moser and Hachhofer, 1932).

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Abbreviations used in the index.

alc. — alcohol
aq. — aqueous
corr. — correction
C.S.T. — critical solution temperature

distr. — distribution data
f.p. — freezing points
liq.-vap. — liquid-vapor
soln. — solution
soly. — solubility

A + BF ₃	261
in H ₂ O	1
in sea water	4
in aq. electrolytes	1, 2, 4
in nitromethane + H ₂ O	3
in liquid oxygen, nitrogen, methane, krypton	4
in olive oil, paraffin	4
in organic solvents	2, 3
in Pd, other metals	4
Acetamide + CaCl ₂	596
+ ICl	1290
Acetic acid + Ba acetate	305
+ benzene + Ag ClO ₄	87
+ Co acetate	509
+ Ca (NO ₃) ₂	628
+ Cu acetate	911
+ HClO ₄	1122
+ HNO ₃	1132
+ H ₃ PO ₃	1148
(+ other compds.) + H ₃ SO ₄	1166
+ HgCl ₂	1226
+ ICl	1289
Acetone + Br ₂	450
+ Cl ₂	787
+ CO (NO ₃) ₂ + H ₂ O	838
+ HBr	1105
+ HCl mps.	1121
Acetophenone + H ₃ PO ₃	1148
Acetylene + CO ₂ (P-V)	494
+ HBr	1106
2Acetyl - 1Naphthol + H ₃ BO ₃	282
Acetyl nitrate + HNO ₃	1131
Actinium compounds	
— separation from lanthanum oxide	4
— extr'n from aq. th (NO ₃) ₄	5
— soly. of Ac emanations	5
Adamsite + AsCl ₃	230
Ag + Ag ₂ O	7, 126
+ As	229
3Ag + BiCl ₃ ⇌ 3AgCl + Bi	7
Ag in Cu	7
Ag + Cu in aq KCN	904
+ CuBr ⇌ Ag Br + Cu	7
+ CuCl ⇌ AgCl + Cu	7
distr. betwn. two metals, or metal + salt	7
in Hg	6, 7

+ Hg in aq. AgNO ₃ + Hg (NO ₃) ₂	6
+ Hg in aq. nitrate solus.	6
in H ₂ O	5
in aq. solns of KI, H ₂ SO ₄ , H ₂ O ₂ , Thiourea, FeCl ₃	6
2Ag + PbCl ₂ ⇌ 2AgCl + Pb	7, 78
+ PbI ₂ ⇌ 2AgI + Pb	7
4Ag + Pb ₂ P ₂ O ₇ ⇌ Ag ₄ P ₂ O ₇ + 2Pb	7
Ag + PbS	7
2Ag + PbS ⇌ Ag ₂ S + Pb	7
Ag in aq. Thiourea (+ H ₂ SO ₄ , H ₂ O ₂ , FeCl ₃)	6
Ag - Au in aq. KCN	6, 243
Ag - Cu in aq KCN (also + H ₂ O ₂)	6
Ag acetate in acetic acid	35
in acetic acid + Na acetate, LiNO ₃	36
in aq. acetic acid	27
in aq. acetone	34
in aq. AgClO ₄ (+ ethanol)	28
in aq. AgNO ₃	27
in aq. AgNO ₃ + ethanol	28
+ AgNO ₃ + acetic acid	35
+ AgNO ₃ in aq. HNO ₃	27
+ Ag ₂ SO ₄ + H ₂ O	133
in aq. Ba(NO ₃) ₂ (+ ethanol)	33
in aq. Co acetate	30
in aq. Ca(NO ₃) ₂ + ethanol, acetane	33
in aq. Cd acetate	30
in aq. dioxane	34
in aq. ethanol	34
in aq. HNO ₃	27
in H ₂ O	26
+ K acetate + acetic acid	36
in aq. K acetate	29
in aq. K acetate + ethanol	30
in aq. KClO ₃ + dioxane	34
in aq. KNO ₃	32
in aq. KNO ₃ + dioxane	32
in aq. KNO ₃ + ethanol, acetane	33
in aq. La(NO ₃) ₃	33
in aq. LiNO ₃ , Co(NO ₃) ₂	32
in aq. LiNO ₃ + ethanol	33
in aq. Na acetate (+ ethanol)	29
in aq. NaClO ₃ + dioxane	34
in aq. NaClO ₄	33
in aq. NaNO ₃	31
in aq. NaNO ₃ + dioxane	31

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in aq. NaNO ₃ + ethanol, acetone	33	in aq. NaBr, NH ₄ Br, CoBr ₂	14
in aq. organic solvents	34, 35	+ NaCl \rightleftharpoons AgCl + NaBr	18
in aq. Pb acetate	30	in aq. Na glycinate	17
in liq. SO ₂	36	in aq. Na ₂ SO ₃	15, 16
in aq. Sr acetate	30	in aq. Na ₂ SO ₄	17
in aq. Sr(NO ₃) ₂ (+ ethanol, acetone)	33	in aq. Na ₂ S ₂ O ₃	15
Ag acetyl propionate	44	+ PbBr ₂	18
Ag anthracene sulfonates in H ₂ O	49	in liq. SO ₂	18
Ag antipyrine ClO ₄	87	in aq. Thiocyanime	17
Ag ₃ AsO ₃ in H ₂ O	8	-Thiosinamine in H ₂ O	19
Ag ₃ AsO ₄ in H ₂ O	8	in aq. Thiourea	17
Ag benzoate in aq. acids	47	AgBrO ₃ in aq. acetic acid	20
in alcohol	47	in aq. acetone	24
in H ₂ O	46	in aq. AgNO ₃	20
in aq. salt solns.	47	in aq. alcohols	24, 25
AgBF ₄ + toluene + H ₂ O	92	in six unsat. alcohols	25
Ag (Tri Antipyrine) BF ₄ in H ₂ O	8	in aq. Ba(NO ₃) ₂	23, 24
AgBO ₂ in H ₂ O	8	in aq. CH ₃ OH	24
Ag ₂ B ₂ O ₇ in H ₂ O, aq. H ₃ BO ₃	8	in aq. C ₂ H ₅ OH	24
AgBr in aq. acetone + NaBr	18	in aq. dioxane	24, 25
+ AgCl	18	in aq. ethylene glycol	24
+ AgCl + AgNO ₃	18	in aq. glycerol	24
+ AgI	18	in aq. HNO ₃	20
+ AgNO ₃	18	in H ₂ O	19
in aq. AgNO ₃	12	+ KBrO ₃ + H ₂ O	21
+ AlBr ₃	18, 162	in aq. KBrO ₃ + NaNO ₃	21
in CH ₃ OH	17	in aq. KClO ₄ , K ₂ SO ₄ , Mg(NO ₃) ₂ , MgSO ₄ , Ba(NO ₃) ₂ , Na ₂ SO ₄ , CdSO ₄ , Ce(NO ₃) ₃ , KNO ₃	23, 24
in aq. CH ₃ OH + NaBr	18	in aq. Mg(NO ₃) ₂	23, 24
in C ₂ H ₅ OH	17	in aq. NH ₃	20
in aq. C ₂ H ₅ OH + NaBr	18	+ NaBrO ₃ + H ₂ O	21, 22
+ CdBr ₂	18, 702	in aq. NaNO ₃ + KBrO ₃	21
+ Ce \rightleftharpoons AgCl + Br ⁻ (aq.)	14, 15	in aq. NaNO ₃ + Na picrate	24
+ Cu \rightleftharpoons CuBr + Ag	7	in aq. NaNO ₃ , Zn(NO ₃) ₂ , Cd(NO ₃) ₂ , Ca(NO ₃) ₂ , Sr(NO ₃) ₂	24
in ethyl ether	17	in aq. phenol	25
in aq. HBr	9, 10	in aq. 1-propanol	24
in aq. HNO ₃ , H ₂ SO ₄	10	in aq. n-propanol	24
in H ₂ O	9	in aq. pyridine	20
in aq. Hg (C ₂ H ₃ O ₂) ₂	17	in aq. vinyl acetic acid	25
in aq. Hg (NO ₃) ₂ (+ HNO ₃)	15	Ag butyrate in aq. Ag acetate, AgNO ₃ , Na butyrate	41
in aq. Hg (NO ₃) ₂ , Hg ₂ SO ₄	15	in aq. C ₂ H ₅ OH	42
+ KBr	18	in H ₂ O	41
in aq. KBr	12, 13	Ag i-butylate in H ₂ O	42
in aq. KBr + NH ₃	11	Ag butyrate in aq. NaNO ₃	42
in aq. KCN	17	Ag ₂ C ₂ in aq. acids	25
+ KI \rightleftharpoons AgI + KBr	18	in aq. AgNO ₃ , AgClO ₄ , NaClO ₄	26
in aq. KNO ₃ , LiNO ₃ , Ba (NO ₃) ₂ , Mn(NO ₃) ₂	17	Ag C(CN) ₃ in H ₂ O	52
in aq. KSCN	16	AgCN in aq. AgNO ₃	51
in aq. methyl and ethyl amine	11, 12	in aq. HCN	51
in liq. NH ₃	18	in HCN (+ H ₂ SO ₄ , HNO ₃)	51
in aq. NH ₃	10, 11	in H ₂ O	51
in aq. NH ₃ + KBr	11	in aq. KCN	51
in aq. NH ₄ Br, NH ₄ Cl, NH ₄ I, gelatine, erythrosine	14	in aq. NH ₃	51
in aq. (NH ₄) ₂ CO ₃	17	+ NaCN	52
in aq. NH ₄ SCN, Ca(SCN) ₂ , Ba(SCN) ₂ , Al(SCN) ₃	17	in liq. SO ₂	52
+ NaBr	18		

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$\text{AgCN} \cdot \text{NaCN}$ in H_2O , aq. alcohol	52	$+ \text{MgCl}_2$	77
$\text{AgCN} \cdot \text{TlCN}$ in H_2O	52	in aq. MgCl_2	67, 68
AgCNO , see AgOCN		$+ \text{MnCl}_2$	78
AgCNS , see AgSCN		in liq. NH_3	77
Ag_2CO_3 in H_2O	58	in aq. NH_3	63, 64
$\text{Ag}_2\text{C}_2\text{O}_4$ in H_2O , aq. HNO_3 , aq. $\text{K}_2\text{C}_2\text{O}_4$	59	in aq. $\text{NH}_3 + \text{AgNO}_3$, KCl , KNO_3	64
Ag caproates in H_2O	46	$+ \text{NH}_4\text{Cl}$	77
$\text{AgCl} + \text{AgBr}$	18	in aq. NH_4Cl	68
$+ \text{AgBr} + \text{AgNO}_3$	18	in aq. NH_4NO_3 , NaNO_3	72
$+ \text{AgI}$	77	in aq. solns. of nitrates	71, 72
$+ \text{AgNO}_3$	77	$+ \text{NaBr} \rightleftharpoons \text{NaCl} + \text{AgBr}$	18
in aq. AgNO_3	65	$+ \text{NaCl}$	77
$+ \text{AgOH}$ in aq. KOH	63	in aq. NaCl	68, 69, 70
$+ \text{Ag}_2\text{S}$	77	in aq. $\text{NaCl} + \text{NaClO}_4$	70
$+ \text{Ag}_2\text{SO}_4$	77	in aq. Na_2SO_3 ($+ \text{Ce}^{+4}$)	73, 74
in aq. Al , Ba , Ca , K , Na , NH_4 Thiocyanates	74	in aq. $\text{Na}_2\text{S}_2\text{O}_3$, Na glycolate	74
$+ \text{AlCl}_3$	177	$2\text{AgCl} + \text{Pb} \rightleftharpoons 2\text{Ag} + \text{PbCl}_2$	7, 78
in aq. BaCl_2 , CoCl_2 , CuCl_2	66	$\text{AgCl} + \text{PbCl}_2$	77
in aq. $\text{Ba}(\text{NO}_3)_2$, KNO_3 , $\text{La}(\text{NO}_3)_3$	71	$2\text{AgCl} + \text{Pbs} \rightleftharpoons \text{Ag}_2\text{S} + \text{PbCl}_2$	78
$+ \text{BeCl}_2$	77	AgCl in pyridine	76
$+ \text{BeCl}_2 + \text{Pyridine}$	77	in aq. RbCl , SrCl_2 , ZnCl_2	70
$3\text{AgCl} + \text{Bi} \rightleftharpoons \text{BiCl}_3 + 3\text{Ag}$	7	in liq. SO_2	77
$\text{AgCl} + \text{Br}^- \rightleftharpoons \text{AgBr} + \text{Cl}^-$ (aq.)	14, 15	in aq. solns. of sulfates	72, 73
in CH_3OH , $\text{C}_2\text{H}_5\text{OH}$	76	in aq. Thiourea, Thiocyanine	75
in aq. CH_3OH	75	- Thiourea salts in H_2O	78
in aq. $\text{CH}_3\text{OH} + \text{HCl}$	75, 76	$+ \text{TlCl}$	77
$+ \text{CaCl}_2$	597	in aq. urea, glycine	74
in aq. CaSO_4 , K_2SO_4	72	AgClO_2 in H_2O	78
$+ \text{CdCl}_2$	78	AgClO_3 in H_2O	78
$+ \text{CdCl}_2 + \text{PbCl}_2$	78	$+ \text{NaClO}_3 + \text{H}_2\text{O}$	79
in aq. solns. of chlorides	66-70	AgClO_4 + aniline + H_2O	83, 84
$+ \text{CsCl}$	77	$+ \text{benzene} + \text{H}_2\text{O}$	80-82
$+ \text{Cu} \rightleftharpoons \text{Ag} + \text{CuCl}$	7	in benzene, toluene, aniline	85
$+ \text{Cu} \rightleftharpoons \text{CuCl} + \text{Ag}$	7	$+ \text{benzene} + \text{acetic acid}$	87
$+ \text{CuCl}$	935	in chlorobenzene, nitrobenzene, cyclohexane,	
$2\text{AgCl} + \text{Cu}_2\text{S} \rightleftharpoons \text{Ag}_2\text{S} + 2\text{CuCl}$	78	pyridine, furfural, cellosolve, m-xylene	86
AgCl in ethyl ether ($+ \text{LiClO}_4$)	77	in aq. HClO_4	80
in aq. HCN	63	in H_2O	79
in aq. HCl	60, 61	in organic solvents	85, 86
in aq. $\text{HCl} + \text{NaCl}$	61	$+ \text{pyridine} + \text{H}_2\text{O}$	84
in aq. HNO_3	61, 62	$+ \text{toluene} + \text{H}_2\text{O}$	82, 83
in H_2O	59, 60	Ag chlorobenzene in H_2O	48
in aq. H_2SO_4	62, 63	Ag cinnamate in H_2O	48
$+ \text{HgCl}_2$	77	Ag citrate in H_2O	46
$+ \text{Hg}_2\text{Cl}_2$	77	$\text{Ag}[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]$ in H_2O	833
$+ \text{InCl}_3$	78, 1296	$\text{Ag}[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2\text{C}_2\text{O}_4]$ in H_2O	833
in aq. KCN , $(\text{NH}_4)_2\text{CO}_3$, $(\text{NH}_4)_2\text{S}_2\text{O}_3$,		Ag_2CrO_4 in aq. CrO_3	87, 88
$(\text{NH}_4)_2\text{S}_2\text{O}_3$	73	in aq. HNO_3	88
in aq. KCl	66, 67	in H_2O	87, 88
$+ \text{KI}$	77	$+ 2\text{I}^- \rightleftharpoons 2\text{AgI} + \text{CrO}_4^{2-}$	90
$+ \text{KNO}_3$ ($+ \text{BaCl}_2$)	78	in aq. NH_3	88
in aq. KOH ($+ \text{KCl}$)	53	in aq. salt solns.	89
in aq. $\text{La}_2(\text{SO}_4)_3$, MgSO_4	73	$\text{Ag}_2\text{Cr}_2\text{O}_7$ in aq. $\text{C}_2\text{H}_5\text{OH}$	90
$+ \text{LiCl}$		in aq. HNO_3	88
$+ \text{LiNO}_3 \rightleftharpoons \text{AgNO}_3 + \text{LiCl}$	78	in H_2O	87, 88
$2\text{AgCl} + \text{Li}_2\text{SO}_4 \rightleftharpoons \text{Ag}_2\text{SO}_4 + 2\text{LiCl}$	78	Ag cupferrate in H_2O	46
AgCl in aq. methylamine, ethylamine	65	Ag diethyl acetate in H_2O	38, 39

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Ag p-diethylemino benzilidene rhodanate in aq.		in aq. Thiourea, Thiocyanime	99
C_2H_5OH	49	thiosinamine in H_2O	100
Ag dipropyl acetate in H_2O	39	+ $TiNO_3 \rightleftharpoons AgNO_3 + TiI$	100
Ag ethyl xanthate in H_2O	40	$2AgI + Ti_2SO_4 \rightleftharpoons Ag_2SO_4 + 2TiI$	100
AgF in BrF_3	92	AgI · allyl thiocarbamide in H_2O	100
$Ag_3Fe(CN)_4$ in H_2O	52	$AgIO_3$ in aq. $AgNO_3$ alanine	104
Ag fulminate in H_2O	53	in aq. glycine and alanine	106
Ag fumarate in H_2O	42	in aq. HNO_3	103
AgF in HF	91	in H_2O	101
in aq. HF	91	+ $I_2O_5 + H_2O$	102
in H_2O	90	+ $KIO_3 + H_2O$	104
+ $MgF_2 + H_2O$	91	+ $LiIO_3 + H_2O$	104
+ ZnF_2	92	in aq. NH_3	103
AgF_2 in HF	92	in aq. NH_3 + salts	104
$AgGeF_6$ in H_2O	92	+ $NH_4IO_3 + H_2O$	104
Ag_3GeF_6 in H_2O	1073	+ $NaIO_3 + H_2O$	104
Ag helianthene in H_2O	49	in aq. pyridine	106
Ag heptate in H_2O	48	in aq. salt solns.	105
Ag hexaacetates in H_2O	46	in aq. salts + NH_3	104
$Ag_2HgI_4 + Cu_2HgI_4$	100	$AgIO_3 + Ag_2O + H_2O$	106, 7
Ag_2HPO_4 in aq. H_3PO_4	128	+ $HIO_4 + H_2O$	106, 7
AgH_2PO_4 in aq. H_3PO_4	128	+ H_2O	106, 7
$AgHSO_4$ in aq. H_2SO_4	132	Ag iodoate in H_2O	50
AgI in aq. acetone	98	Ag levulicete	44
in acetone + KI, NaI	99	Ag malate in H_2O	43
+ AgBr	18	Ag maleate in H_2O	42
+ AgCl	77	Ag methionate in H_2O	26
+ $AgNO_3$	100	Ag methoxy hexaacetate in H_2O	48
in aq. $AgNO_3$	94	Ag methyl oilpate in H_2O	43
in aq. $Al(CNS)_3$, $Ba(CNS)_3$, $Ba(NO_3)_2$, $Ca(CNS)_2$, $Hg(NO_3)_2$	96	Ag methyl ethyl acetate in H_2O	38, 39
in aq. CH_3OH , C_2H_5OH , acetone, pyridine	99	$AgMnO_4$ in aq. $AgClO_4$, $AgNO_3$	107
$2AgI + CrO_4^{2-} \rightleftharpoons Ag_2CrO_4 + 2I^-$	90	$Ag_2MoO_4 + AgNO_3 + H_2O$	108
AgI + CsCl	100	+ Ag_2SO_4	108
+ CuCl	100	in H_2O	108
+ CuI	100, 953	+ Na_2MoO_4	106
in ethyl ether	99	+ $Na_2MoO_4 + H_2O$	106
+ HgI_2	100	+ $Na_2SO_4 \rightleftharpoons Ag_2SO_4 + Na_2MoO_4$	108
in aq. HNO_3 , H_2SO_4 , KOH	93, 94	Ag monochloro acetate in aq. $AgNO_3$	37
in H_2O , aq. HI	93	in aq. HNO_3	37
+ I_2 + benzene	100	in H_2O	36
+ KBr \rightleftharpoons KI + AgBr	18	in aq. Na chloroacetate	37
in aq. KBr, KCN, KSCN, KNO_3 , $LiNO_3$, $Mn(NO_3)_2$, NH_4SCN , NaCl, Na_2SO_3	97	in aq. nitrates	37, 38
+ KCl	100	AgN_3 in H_2O	106
in aq. KI	95, 96	$AgN(CN)_2$ in H_2O	52
in aq. KI + methanol, ethanol, acetone	96	$Ag(NH_4)_2ReO_4$ in aq. NH_3	129
+ LiCl	100	Ag asphthalene sulfonates in H_2O	49
in aq. NH_3	94	Ag α - naphthoate	48
in liq. NH_3 , liq. SO_2	100	Ag citrohexoate in H_2O	46
+ NaI	100	Ag myristate in H_2O	50
in aq. NaI	94, 95	$AgNO_2$ in acetanitrile	112
+ $NaNO_3 \rightleftharpoons AgNO_3 + NaI$	100	$AgNO_3 + Ag$ acetate + acetic acid	35
in aq. $Na_2S_2O_3$	98	+ Ag acetate in aq. HNO_3	27
$2AgI + Pb \rightleftharpoons PbI_2 + 2Ag$	7	$AgNO_2$ in aq. $AgNO_3$	109
AgI + PbI_2	100	+ $Ba(NO_3)_2 + H_2O$	111
+ RbCl	100	extr. w. C_2H_5OH from aq. KNO_2	112
		+ $Ca(NO_3)_2 + H_2O$	615
		in H_2O	108

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+ KNO ₃ + H ₂ O	110	+ PbNO ₃	123
in aq. NaNO ₂	112	+ succinonitrile + H ₂ O	118
+ NaNO ₂ + H ₂ O	109	+ TlI ⇌ TlNO ₃ + AgI	100
+ Sr(NO ₃) ₂ + H ₂ O	111	+ TlNO ₃	123
AgNO ₃ in acetic acid (+ LiNO ₃)	122	Ag ₂ O + Ag	7
in acetic acid (+ Na acetate)	122	+ B ₂ O ₃ - H ₂ O	8
+ AgBr	18	in aq. C ₂ H ₅ OH	126
+ AgBr + AgCl	18	- CrO ₃ - H ₂ O	87, 88
+ AgCl	77	in aq. glycine, Na glycinate	126
+ AgI	100	in H ₂ O	124
+ AgI ₂ + H ₂ O	104	+ I ₂ O ₅ + H ₂ O	106, 7
+ Ag ₂ MoO ₄ + H ₂ O	108	in aq. KOH (+ KCl)	53
+ Ba(NO ₃) ₂ + H ₂ O	114	+ K ₂ O + B ₂ O ₃	126
+ Ba(NO ₃) ₂ + NaNO ₃	123	in aq. methyl, ethyl amine	126
+ CdCl ₂	123	in aq. NH ₃	125
+ CdI ₂	123, 741	in aq. NaOH, KOH, Ba(OH) ₂	125
+ Cd(NO ₃) ₂	123	+ Na ₂ O + B ₂ O ₃	126
+ Cd(NO ₃) ₂ + KNO ₃	123	- P ₂ O ₅ - H ₂ O	128
in aq. C ₂ H ₅ OH	117	AgOH in H ₂ O	124
in aq. C ₂ H ₅ OH + ether	119	+ AgCl in aq. KOH	63
+ Cu(OH) ₂ + H ₂ O	963	2AgOH + Mg ⁺⁺ ⇌ Mg(OH) ₂ + 2Ag ⁺	126
+ CsNO ₃	123	AgOCN in H ₂ O	52
distr. betwn. H ₂ O and aniline	119	Ag oanthylate in H ₂ O	48
in aq. ether (+ HNO ₃ , C ₂ H ₅ OH)	119	Ag oxybenzoate in H ₂ O	48
+ guanidine nitrate + H ₂ O	118	Ag ₃ PO ₄ in aq. HNO ₃	128
in anhyd. HNO ₃	123	in H ₂ O	127
in aq. HNO ₃	113	+ H ₃ PO ₄ + H ₂ O	128
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+ HgBr ₂	123, 1189	in aq. salts	129
+ HgCl ₂	123, 1229	Ag ₄ P ₂ O ₇ in aq. Na ₄ P ₂ O ₇ , K ₄ P ₂ O ₇	129
+ HgI ₂	123, 1243	+ 2Pb ⇌ Pb ₂ P ₂ O ₇ + 4Ag	7
+ KClO ₃	123	Ag ₂ PO ₃ F in H ₂ O	92
+ KNO ₃	123	Ag valeritate in H ₂ O	49
+ KNO ₃ + H ₂ O	114, 115	Ag phenanthrene sulfonates in H ₂ O	49
+ KNO ₃ + NH ₄ NO ₃	123	Ag phenyl acetate in H ₂ O	39
+ KNO ₃ + NaNO ₃ + TlNO ₃	123	Ag propionate in aq. AgNO ₃ , NaNO ₃	
+ KNO ₃ + TlNO ₃	123	Na propionate	40
+ LiCl ⇌ LiNO ₃ + AgCl	78	in H ₂ O	39
+ LiNO ₃	123	in aq. propionic acid	39
+ NaI ⇌ NaNO ₃ + AgI	100	Ag pyrimidine derivatives	43
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+ NH ₄ NO ₃	123	Ag ₂ S + AgCl	77
+ NH ₄ NO ₃ + acetic acid	122	Al ₂ S	203
+ NH ₄ NO ₃ + Ba(NO ₃) ₂ + H ₂ O	374	+ As ₂ S ₃	242
+ NH ₄ NO ₃ + aq. C ₂ H ₅ OH	116	+ CuCl ⇌ Cu ₂ S + 2AgCl	78
+ NH ₄ NO ₃ + H ₂ O	115, 116	+ Cu ₂ S	130, 964
+ NH ₄ NO ₃ + Pb(NO ₃) ₂ + H ₂ O	117	+ Cu ₂ S + PbS	130
+ NaNO ₃	123	in aq. electrolytes	130
+ NaNO ₃ in aq. C ₂ H ₅ OH	117	in H ₂ O	129, 130
+ NaNO ₃ + NH ₄ NO ₃	123	+ Pb ⇌ 2Ag + PbS	7
+ NaNO ₃ + TlNO ₃	123	+ PbCl ₂ ⇌ PbS + 2AgCl	78
in organic solvents	119-122	+ PbS	130
+ Pb(NO ₃) ₂	123	+ Sb ₂ S ₃	130
+ Pb(NO ₃) ₂ + H ₂ O	117	+ SiS ₂	130
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Ca d camphorate + camphonic acid + H_2O	528	+ CoCl	597
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+ CaSO ₃ + H ₂ O	654, 5
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+ AlF ₃ + H ₂ O.....	182	KNO ₃ + AgCl (+ BaCl ₂).....	78
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+ CoF ₂ + H ₂ O.....	821	+ Ba(NO ₃) ₂ + H ₂ O.....	372, 3
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+ CsBr.....	875	+ Ba(NO ₃) ₂ + NaNO ₃	377
+ CsCl.....	886	+ Ba(NO ₃) ₂ + Sr(NO ₃) ₂	377
+ CsI.....	896	2KNO ₃ + CaCl ₂ ⇌ Ca(NO ₃) ₂ + 2KCl (aq.).....	587, 588, 624
+ CuF ₂ + H ₂ O.....	951	+ CaCrO ₄ ⇌ Ca(NO ₃) ₂ + K ₂ CrO ₄	600
+ FeF ₃ + H ₂ O.....	1032	KNO ₃ + Ca(NO ₃) ₂	629
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K ₂ G ₂ FeF ₆ in H ₂ O.....	1073	+ Cd(NO ₃) ₂ + AgNO ₃	123
KH ₂ AsO ₄ + H ₃ BO ₃ + H ₂ O.....	275	+ Cd(NO ₃) ₂ + RbNO ₃	744
KH ₂ PO ₄ + H ₃ BO ₃ + H ₂ O.....	276	+ Fe(NO ₃) ₃ + H ₂ O.....	1036, 7
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+ AgCl.....	77	+ LiNO ₃ + Cd(NO ₃) ₂	744
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+ BiI ₃ + H ₂ O.....	432	K ₂ O + Ag ₂ O + B ₂ O ₃	126
+ CdI ₂	741	+ CaO + Al ₂ O ₃ + CaSO ₄ + H ₂ O.....	497
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KI + CdI ₂ + H ₂ O.....	734, 5	+ CaO + CO ₂ + Na ₂ O + TiO ₂ + SiO ₂	556
2KI·CdI ₂ in H ₂ O.....	735	+ CaO·SiO ₂ + 2CaO·SiO ₂	630
KI + CsF.....	889	+ Fe ₂ O ₃ + SO ₃ + H ₂ O.....	1064
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$KPO_3 + BiTiO_3$	439	$LiAuCl_4$ in H_2O	248
$K_4P_2O_7 + BiTiO_3$	439	$LiBr + AlBr_3$	162
$KSCN + AgSCN + H_2O$	55, 56	+ $As_2O_3 + H_2O$	237
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+ $Co(SCN)_2 + H_2O$	796	+ $CoBr_2$	505
+ $Hg(SCN)_2 + H_2O$	1202	+ $CoBr_2 + H_2O$	504
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+ $Ag_2SO_4 + H_2O$	136, 7	+ CsF	889
+ $Al_2(SO_4)_3 + H_2O$	216	+ CsI	896
$3K_2SO_4 + 2Al_2(SeO_4)_3 \rightleftharpoons 2Al_2(SO_4)_3$		+ $InBr_3 + H_2O$	1293
+ $3K_2SeO_4(+H_2O)$	226	$Li_2CO_3 + CaCO_3$	556
$K_2SO_4 + Ba(MnO_4)_2 \rightleftharpoons BaSO_4 + 2KMnO_4$		$LiCl + AgCl$	77
in H_2O	393	+ AgI	100
+ $BaSO_4$	393	+ $AgNO_3 \rightleftharpoons LiNO_3 + AgCl$	
+ $BaSO_4 + H_2O$	393	$2LiCl + Ag_2SO_4 \rightleftharpoons Li_2SO_4 + 2AgCl$	78
+ $BeSO_4 + H_2O$	419, 20	$LiCl + AlBr_3 +$ nitrobenzene.....	161
+ $Bi_2(SO_4)_3 + H_2O$	438	+ $AlCl_3$	177
+ $BiTiO_3$	439	+ $As_2O_3 + H_2O$	237
+ $CaCl_2 + CaSO_4 + 2KCl(+H_2O)$	596, 678	+ $BoCl_2$	353
+ $CaSO_4$	687	+ $BoCl_2 + H_2O$	347
+ $CaSO_4 + H_2O$	671-3	+ BaF_2	360
+ $CaSO_4 + MgSO_4$	687	+ $BeCl_2$	406
+ $CaSO_4 + Na_2SO_4$	687	+ $BeCl_2 + H_2O$	404, 5
+ $CdSO_4$	762	+ $BiTiO_3$	439
+ $CdSO_4 + H_2O$	753, 4	+ $CaCl_2$	597
+ $CdSO_4$ in H_2O	754	+ $CoCl_2 + H_2O$	588
+ $Ce_2(SO_4)_3 + H_2O$	776, 7	$2LiCl + CaF_2 \rightleftharpoons CaCl_2 + 2LiF$	597
+ $CoCl_2 \rightleftharpoons CoSO_4 + 2KCl$	856	$LiCl_2 + CdCl_2$	728
+ $CoCl_2 \rightleftharpoons CoSO_4 + 2KCl(+H_2O)$	801, 05	+ $CdCl_2 + H_2O$	721, 2
+ $CoSO_4$	856	$2LiCl + CdSO_4 \rightleftharpoons CdCl_2 + Li_2SO_4$	728
+ $CoSO_4 + H_2O$	847, 8	$LiCl + CoCl_2$	818
+ $CsCl$	885	+ $CoCl_2 + H_2O$	805-7
+ Cs_2SO_4	903	$2LiCl + CoSO_4 \rightleftharpoons CoCl_2 + Li_2SO_4$	818
+ $CuSO_4$	997	+ $CsBr$	875
+ $CuSO_4 + H_2O$	977, 8	+ $CsCl$	885
+ $CuSO_4$ in H_2O	978	+ $CsCl + H_2O$	881
+ $CuSO_4 + CuCl_2 + KCl + H_2O$	974	+ CsF	889
+ $CuSO_4 + Na_2SO_4$	997	+ CsI	896
+ $CuSO_4 + (NH_4)_2SO_4 + H_2O$	963	$2LiCl + Cs_2SO_4 \rightleftharpoons 2CsCl + Li_2SO_4$	885
+ $Di_2(SO_4)_3 \cdot 2H_2O$ in H_2O	1001	+ $CuCl_2 + H_2O$	935
+ $FeSO_4 \cdot 6H_2O$ in H_2O	1053	+ $CuCl_2 + H_2O$	941
+ $Fe_2(SO_4)_3 + H_2O$	1064	+ $HgCl_2$	1229
+ $H_3BO_3 + H_2O$	271	+ $HgCl_2 + H_2O$	1211
+ H_2O_2	1148	+ $InCl_3 + H_2O$	1295, 6
+ $Ti_2SO_4 + CuSO_4 + H_2O$	994	$3LiCl \cdot mS_2$	1300
$K_2Zn + FeK_2(SO_4)_2 + H_2O$	1054	$2LiCl \cdot LiHS_2 \cdot LiOH$	1300
$K_2Zn(SO_4)_2 + K_2Cu(SO_4)_2 + H_2O$	980	$LiCl \cdot 4LiHS_2 \cdot 4LiOH$	1300
$K_2S_2O_8 + BaS_2O_6 + H_2O$	396	$LiCl + NaCl + CsCl$	885
$3K_2SO_4 + 2Al_2(SO_4)_3 \rightleftharpoons 2Al_2(SeO_4)_3 + 3K_2SO_4$		$LiF + AlF_3$	186
(+ H_2O).....	226	+ $AlF_3 + H_2O$	185
$K_2SeO_4 + Al_2(SeO_4)_3 + H_2O$	228	+ BaF_2	360
+ $CaSeO_4 + H_2O$	690	+ BeF_2	409
$K_2SiO_3 + BiTiO_3$	439	$2LiF \cdot BaF_2$ in H_2O	406, 9
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$LaF_3 + CsF$	889	$2LiF + CoCl_2 \rightleftharpoons CoF_2 + 2LiCl$	597

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$\text{LiF} + \text{CaF}_2$	603	Mandellic acid + Cs mandelate + H_2O	878
$2\text{LiF} + \text{CaSiO}_3 \rightleftharpoons \text{CaF}_2 + \text{Li}_2\text{SiO}_3$	603	Mannitol + $\text{H}_3\text{BO}_3 + \text{H}_2\text{O}$	278
$\text{LiF} + \text{CsBr}$	875	Mesitylene + HBr	1105
+ CsCl	886	Methane + CO_2 (L-V).....	491
+ CsI	896	+ H_2	1095
$\text{Li}_2\text{Fe}(\text{CN})_6 \cdot 3\text{Co}_2\text{Fe}(\text{CN})_6$	796	+ H_2 + ethane.....	1095
+ $\text{InCl}_3 + \text{H}_2\text{O}$	1296	+ H_2 + ethene.....	1095
Li_2GeF_6 in H_2O	1073	+ $\text{H}_2 + \text{N}_2$	1095
$\text{LiI} + \text{BiI}_3 + \text{H}_2\text{O}$	432	Methanol + Br_2	450
+ CsBr	875	+ CO_2 (v.p.).....	484
+ CsCl	886	+ Cl_2	787
+ CsF	889	+ HBr	1105
+ I_2	1287	+ HCl	1121
+ $\text{InI}_3 + \text{H}_2\text{O}$	1298	+ H_2O_2	1147
$\text{LiInS}_2 \cdot \text{LiOH} \cdot 9\text{H}_2\text{O}$	1300	Methoxyhumic acid - Ca acetate - H_2O	509
+ $\text{LiOH} \cdot 2\text{LiCl}$	1300	Methyl acetate + Cl_2	787
$4\text{LiInS}_2 \cdot 4\text{LiOH} \cdot \text{LiCl} \cdot 10\text{H}_2\text{O}$	1300	Methyl bromide + GeCl_3	1066
$\text{LiIO}_3 + \text{AgIO}_3 + \text{H}_2\text{O}$	104	Methyl chloride + BCl_3	257
Lime see CaO , $\text{Ca}(\text{OH})_2$		+ BF_3	259
$\text{LiNO}_3 + \text{AgNO}_3$	123	+ CO_2 (P-V).....	494
+ $\text{AgCl} \rightleftharpoons \text{AgNO}_3 + \text{LiCl}$	78	+ Cl_2	787
+ $\text{Ba}(\text{NO}_3)_2$	377	+ GeCl_3	1066
+ $\text{Ba}(\text{NO}_3)_2 + \text{KNO}_3$	377	+ HBr	1105
+ $\text{Ca}(\text{NO}_3)_2$	629	+ HCl	1121
+ $\text{Cd}(\text{NO}_3)_2$	744	Methyl-o,m-cresyl ethers + GeCl_4	1073
+ $\text{Cd}(\text{NO}_3)_2 + \text{KNO}_3$	744	Methyl ether + CO_2 (v.p.).....	484
+ CsNO_3	899	+ HBr	1105
+ $\text{NaNO}_3 + \text{Cd}(\text{NO}_3)_2$	744	+ HCl	1121
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$\text{LiOH} \cdot \text{LiInS}_2 \cdot 2\text{LiCl}$	1300	Methyl iodide + CaCl_3	1066
+ $\text{LiInS}_2 \cdot 9\text{H}_2\text{O}$		Methyl thiocyanate + $\text{Co}(\text{SCN})_2$	796
$4\text{LiOH} \cdot 4\text{LiInS}_2 \cdot \text{LiCl} \cdot 10\text{H}_2\text{O}$	1300	Methylene dichloride + Cl_2	787
$\text{Li}_2\text{SO}_4 + 2\text{AgCl} \rightleftharpoons \text{Ag}_2\text{SO}_4 + 2\text{LiCl}$	78	$3\text{Mg} + 2\text{AlCl}_3 \rightleftharpoons 3\text{MgCl}_2 + 2\text{Al}$	177
+ Ag_2SO_4	143	$\text{Mg} + \text{CaCl}_2 \rightleftharpoons \text{MgCl}_2 + \text{Ca}$	495
+ $\text{Ag}_2\text{SO}_4 + \text{H}_2\text{O}$	137	$\text{Mg}_3\text{Bi}_2(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$ in conc. HNO_3	434
+ $\text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	217, 218	$\text{MgBr}_2 + \text{AlBr}_3$	162
+ BaSO_4	393	+ $\text{InBr}_3 + \text{H}_2\text{O}$	1293
+ $\text{Bi}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	439	$\text{MgCO}_3 + \text{CaCO}_3 + \text{H}_2\text{O}$	545, 6
+ BiTiO_3	439	+ CaCO_3 in H_2O	546
+ CaSO_4	687	+ $\text{CaSO}_4 \rightleftharpoons \text{CaCO}_3 + \text{MgSO}_4$	546
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+ $\text{CdSO}_4 + \text{H}_2\text{O}$	754	$\text{MgCl}_2 + \text{AgCl}$	77
+ $\text{CoCl}_2 \rightleftharpoons \text{CoSO}_4 + 2\text{LiCl}$	818	$3\text{MgCl}_2 + 2\text{Al} \rightleftharpoons 3\text{Mg} + 2\text{AlCl}_3$	177
+ CoSO_4	856	$\text{MgCl}_2 + \text{AlCl}_3$	177
+ $2\text{CsCl} \rightleftharpoons \text{Cs}_2\text{SO}_4 + 2\text{LiCl}$	885	+ BaCl_2	353
+ Cs_2SO_4	903	+ $\text{BaCl}_2 + \text{KCl}$	353
+ $\text{CuSO}_4 + \text{H}_2\text{O}$	988	+ BeCl_2	406
+ $\text{CuSO}_4 + (\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{O}$	983	+ $\text{Ca} \rightleftharpoons \text{Mg} + \text{CaCl}_2$	495
+ $\text{FeSO}_4 + \text{H}_2\text{O}$	1054	+ CaCl_2	597
+ $(\text{NH}_4)_2\text{SO}_4 + \text{FeSO}_4 + \text{H}_2\text{O}$	1054	+ $\text{CaCl}_2 + \text{H}_2\text{O}$	580-4
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+ $\text{CaF}_2 \rightleftharpoons \text{CaSiO}_3 + 2\text{LiF}$	603	+ $\text{CaCl}_2 + \text{NaCl} + \text{KCl} + \text{H}_2\text{O}$	587
+ CaSiO_3	693	+ $\text{CaCl}_2 + \text{SrCl}_2 + \text{KCl} + \text{NaCl} + \text{H}_2\text{O}$	587
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+ AlCl ₃	177
+ BaCl ₂	353
+ CaCl ₂	587

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$3\text{NaF} + \text{Al} \rightleftharpoons \text{AlF}_3 + 3\text{Na}$	147	$\text{NaNO}_2 + \text{AgNO}_2 + \text{H}_2\text{O}$	109
$\text{NaF} + \text{AlF}_3$	186	$\text{NaNO}_3 + \text{AgNO}_3$	123
$+ \text{AlF}_3 + \text{CaF}_2$	186	$+ \text{AgNO}_3 + \text{BaNO}_3$	123
$+ \text{AlF}_3 + \text{H}_2\text{O}$	182-5	$+ \text{AgNO}_3$ in aq. $\text{C}_2\text{H}_5\text{OH}$	117
$1\text{NaF} \cdot 4\text{AlF}_3$ in aq. salt solns.....	185	$+ \text{AgNO}_3 + \text{KNO}_3 + \text{TiNO}_3$	123
$\text{NaF} + \text{BaCl}_2 + \text{CaCl}_2 + \text{KF}$	353	$+ \text{AgNO}_3 + \text{NH}_4\text{NO}_3$	123
$+ \text{BaF}_2$	360	$+ \text{AgNO}_3 + \text{TiNO}_3$	123
$\text{NaF}_2 + \text{BaSiO}_3$ (+ other salts).....	400	$+ \text{Al}(\text{NO}_3)_3 + \text{H}_2\text{O}$	191
$\text{NaF} + \text{BaTiO}_3$	400	$+ \text{Al}(\text{NO}_3)_3 + \text{HNO}_3 + \text{H}_2\text{O}$	192
$+ \text{BeF}_2$	409	$+ \text{Al}(\text{NO}_3)_3 + \text{KNO}_3 + \text{H}_2\text{O}$	192
$+ \text{BeF}_2 + \text{H}_2\text{O}$	408	$2\text{NaNO}_3 + \text{BaCl}_2 \rightleftharpoons \text{Ba}(\text{NO}_3)_2 + 2\text{NaCl}$ in H_2O	342
$+ \text{BeF}_2$ in H_2O	408	$\text{NaNO}_3 + \text{Ba}(\text{NO}_3)_2$	377
$2\text{NaF} \cdot \text{BaF}_2$ in H_2O	408, 9	$+ \text{Ba}(\text{NO}_3)_2 + \text{H}_2\text{O}$	373
$\text{NaF} + \text{BiTiO}_3$	439	$+ \text{Ba}(\text{NO}_3)_2 + \text{KNO}_3$	377
$+ \text{CaF}_2$	603	$+ \text{Ba}(\text{NO}_3)_2 + \text{NH}_4\text{NO}_3$	377
$+ \text{CaF}_2 + \text{KF}$	603	$+ \text{Ca}(\text{NO}_3)_2$	629
$+ \text{CdF}_2$	732	$+ \text{Ca}(\text{NO}_3)_2 + \text{CaS}_2\text{O}_3 + \text{H}_2\text{O}$	688

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+ $\text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O}$	621, 2	+ $\text{Ce}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	778
+ $\text{Ca}(\text{NO}_3)_2 + \text{KNO}_3$	629	+ CoSO_4	856
+ $\text{Mg}(\text{NO}_3)_2 + \text{KNO}_3 + \text{Ca}(\text{NO}_3)_2$	629	+ $\text{CoSO}_4 + \text{H}_2\text{O}$	852, 3
+ $\text{Ca}(\text{NO}_3)_2 + \text{KNO}_3 + \text{H}_2\text{O}$	624	+ $\text{CS}_2\text{SO}_4 + \text{H}_2\text{O}$	903
+ $\text{Ca}(\text{NO}_3)_2 + \text{Mg}(\text{NO}_3)_2$	629	+ $\text{Cu}(\text{NO}_3)_2 \rightleftharpoons \text{CuSO}_4 + 2\text{NaNO}_3(+\text{H}_2\text{O})$	992
+ $\text{Ca}(\text{NO}_3)_2 + \text{Pb}(\text{NO}_3)_2$	629	+ CuSO_4	997
+ $\text{Ca}(\text{NO}_3)_2 + \text{Sr}(\text{NO}_3)_2$	629	+ $\text{CuSO}_4 + \text{H}_2\text{O}$	991, 2
$2\text{NaNO}_3 + \text{CaS}_2\text{O}_3 \rightleftharpoons \text{Ca}(\text{NO}_3)_2 + \text{Na}_2\text{S}_2\text{O}_3(\text{aq.})$	624	+ $\text{CuSO}_4 + \text{K}_2\text{SO}_4$	997
$\text{NaNO}_3 + \text{CaS}_2\text{O}_3 + \text{Na}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O}$	688	+ $\text{CuSO}_4 + \text{CuCl}_2 + \text{NaCl} + \text{H}_2\text{O}$	974
+ $\text{Cd}(\text{NO}_3)_2$	744	+ $\text{CuSO}_4 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$	992
+ $\text{Cd}(\text{NO}_3)_2 + \text{LiNO}_3$	744	+ $\text{FeSO}_4 + \text{H}_2\text{O}$	1057
+ $\text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{O}$	957	+ $\text{H}_3\text{BO}_3 + \text{H}_2\text{O}$	272
$2\text{NaNO}_3 + \text{CuSO}_4 \rightleftharpoons \text{Cu}(\text{NO}_3)_2 + \text{Na}_2\text{SO}_4(+\text{H}_2\text{O})$	992	$\text{Na}_2\text{S}_2\text{O}_3 + \text{Ag}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O}$	144
+ H_2O	1148	+ $\text{Ca}(\text{NO}_3)_2 \rightleftharpoons \text{CaS}_2\text{O}_3 + 2\text{NaNO}_3(\text{aq.})$	624
+ $\text{NH}_4\text{NO}_3 + \text{Cd}(\text{NO}_3)_2$	744	+ $\text{CaS}_2\text{O}_3 + \text{H}_2\text{O}$	688
$\text{Na}_2\text{O} + \text{Ag}_2\text{O} + \text{B}_2\text{O}_3$	126	+ $\text{CaS}_2\text{O}_3 + \text{NaNO}_3 + \text{H}_2\text{O}$	688
+ $3\text{Al}_2\text{O}_3 + \text{Na}_2\text{O} + 4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{FeO}$	630	+ $\text{BaS}_2\text{O}_6 + \text{H}_2\text{O}$	397
+ $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{FeO} + \text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3$	630	$\text{Na}_2\text{S}_2\text{O}_3 + \text{Al}_2(\text{SeO}_4)_3 + \text{H}_2\text{O}$	228
+ $\text{CaO} + \text{B}_2\text{O}_3$	502	$3\text{Na}_2\text{SeO}_4 + 2\text{Al}_2(\text{SO}_4)_3 \rightleftharpoons 2\text{Al}_2(\text{SeO}_4)_3$	
+ $\text{CaO} + \text{CO}_2 + \text{K}_2\text{O} + \text{TiO}_2 + \text{SiO}_2$	556	+ $\text{Na}_2\text{SO}_4(+\text{H}_2\text{O})$	226
+ $\text{CaO} + \text{SiO}_2$	630	+ $\text{NaSeO}_4 + \text{CaSeO}_4 + \text{H}_2\text{O}$	691
+ $\text{CaO} + \text{SiO}_2 + \text{Ca}_2$	630	$\text{Na}_2\text{SiO}_3 + \text{BaSiO}_3$	400
+ $\text{CaSO}_4 + \text{CaO} + \text{Al}_2\text{O}_3 + \text{H}_2\text{O}$	497	+ BiTiO_3	439
+ GeO_2	1075	+ BaSiO_3	693
+ $\text{P}_2\text{O}_5 + \text{CaO} \cdot \text{P}_2\text{O}_5$	656	$\text{NaSiO}_3 + \text{CaSiO}_3 + \text{NaAlSiO}_4$	693
+ $\text{SiO}_2 + \text{BaO}$	383	$\text{Na}_2\text{TiO}_3 + \text{BiTiO}_3$	439
+ $2\text{SiO}_2 + \text{CaO} \cdot \text{SiO}_2$	630	$\text{Na trifluoroacetate} + \text{Al trifluoroacetate}$	
$\text{NaOH} + \text{Ba}(\text{OH})_2$	383	+ trifluoroacetic acid.....	162
+ $\text{Be}(\text{OH})_2 + \text{H}_2\text{O}$	412	$\text{NaVO}_3 + \text{BiTiO}_3$	439
$\text{Na oxalate} + \text{Cu oxalate} + \text{H}_2\text{O}$	924	$\text{Na}_2\text{VO}_4 + \text{BaSiO}_3(+\text{ other salts})$	400
$\text{NaPO}_2 + \text{BiTiO}_3$	439	$\text{Na}_2\text{WO}_4 + \text{BaSiO}_3(+\text{ other salts})$	400
$\text{Na}_4\text{P}_2\text{O}_7 + \text{BaSiO}_3(+\text{ other salts})$	400	+ $\text{Ce}_2(\text{WO}_4)_3 + \text{H}_2\text{O}$	782
+ BaTiO_3	400, 439	$\text{Naphthalene} + \text{AlBr}_3$	158
$3\text{Na}_4\text{P}_2\text{O}_7 \cdot \text{Fe}_4(\text{P}_2\text{O}_7)_2$ in aq. NaCl , Na citrate	1044	+ AsBr_3	230
$\text{NaSCN} + \text{AgSCN} + \text{H}_2\text{O}$	57	+ AsI_3	231
+ $\text{Ba}(\text{SCN})_2 + \text{H}_2\text{O}$	327	+ $\text{HgBr}_2 + \text{I}_2$	1189
+ $\text{Ca}(\text{SCN})_2 + \text{H}_2\text{O}$	532, 3	+ I_2	1278
$\text{Na}_2\text{SO}_4 + \text{Ag}_2\text{MoO}_4 \rightleftharpoons \text{Ag}_2\text{SO}_4 + \text{Na}_2\text{MoO}_4$	108	$\text{Naphthal} + \text{AsBr}_3$	230
+ Ag_2SO_4	143	Ne campols. , see also Di	
+ $\text{Ag}_2\text{SO}_4 + \text{H}_2\text{O}$	139-141	$\text{Ne} + \text{He}$ in H_2O	1172
+ $\text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	220, 221	$\text{Ni} + \text{As} + \text{Cu}$	229
$3\text{Na}_2\text{SO}_4 + 2\text{Al}_2(\text{SeO}_4)_3 \rightleftharpoons 2\text{Al}_2(\text{SO}_4)_3$		+ $\text{Cu} + \text{S}$	905
+ $3\text{Na}_2\text{SeO}_4(+\text{H}_2\text{O})$	226	+ $\text{FeO} \rightleftharpoons \text{Fe} + \text{NiO}$	1006
$\text{Na}_2\text{SO}_4 + \text{BaCl}_2$	353	+ $\text{FeSiO}_3 \rightleftharpoons \text{Fe} + \text{NiSiO}_3$	1006
+ $\text{BaCl}_2 \rightleftharpoons \text{BaSO}_4 + 2\text{NaCl}$	393	$\text{Ni}_2\text{Bi}_2(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$ in conc. HNO_3	434
+ BaSO_4	393	NiCe nitrate	772
+ $\text{BeSO}_4 + \text{H}_2\text{O}$	421, 2	$\text{NiCl}_2 + \text{CdCl}_2 + \text{H}_2\text{O}$	725
+ $\text{BaSiO}_3(+\text{ other salts})$	400	+ $\text{CdCl}_2 + \text{NaCl} + \text{H}_2\text{O}$	721
+ BiTiO_3	439	+ CaCl_2 distr. betwn. capryl alcohol + H_2O	817
+ $\text{CaCO}_3 \rightleftharpoons \text{CaSO}_4 + \text{Na}_2\text{CO}_3(+\text{H}_2\text{O})$	682	+ $\text{CoCl}_2 + \text{H}_2\text{O}$	812
+ CaSO_4	687	+ $\text{CoCl}_2 + \text{FeCl}_3 + \text{H}_2\text{O}$	802
+ $\text{CaSO}_4 + \text{H}_2\text{O}$	676, 7	+ $\text{FeCl}_2 + \text{H}_2\text{O}$	1016
+ $\text{CaSO}_4 + \text{K}_2\text{SO}_4$	687	+ $\text{FeCl}_3 + \text{H}_2\text{O}$	1025
+ $\text{CaSO}_4 + \text{MgSO}_4$	687	$\text{NiCa}(\text{SO}_4)_2$ in H_2O	902
+ $\text{CdCl}_2 \rightleftharpoons \text{CdSO}_4 + 2\text{NaCl}$	728	$\text{Ni}_2[\text{Ca}(\text{NO}_3)_4]_2 \cdot 24\text{H}_2\text{O}$	1071
+ CdSO_4	762	$\text{NiK}_2(\text{SO}_4)_2 + \text{CuK}_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	981
+ $\text{CdSO}_4 + \text{H}_2\text{O}$	759, 60	$\text{Ni}(\text{NH}_4)_6\text{I}_2 + \text{I}_2$	1287

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$\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	851	$\text{PCl}_3 + \text{AlCl}_3$	177
+ $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	985-7	+ Br_2	450
+ $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	1055, 6	+ I_2	1287
$\text{Ni}(\text{NO}_3)_2 + \text{Co}(\text{NO}_3)_2 + \text{H}_2\text{O}$	837	$\text{PCl}_3 + \text{I}_2$	1287
$\text{NiO} + \text{Cr}_2\text{O}_3$	871	$\text{PCl}_3 + \text{ICl}$	1290
+ $\text{Fe} \rightleftharpoons \text{FeO} + \text{Ni}$	1006	$\text{PCl}_3 + \text{ICl}$	1290
+ $\text{ZnO}_2 + \text{Cr}_2\text{O}_3$	871	$\text{PCl}_3 + \text{AuCl}$ in PCl_3	249
$\text{NiS} + \text{CoS}$	842	$\text{PF}_3 + \text{BF}_3$	260
$\text{Ni}_2\text{S}_3 + \text{Cu}_2\text{S}$	964	$\text{PH}_3 + \text{BF}_3$	260
+ $\text{Cu}_2\text{S} + \text{FeS}$	964	in cyclohexanol.....	1148
$\text{Ni}(\text{SCN})_2 + \text{Co}(\text{SCN})_2 + \text{H}_2\text{O}$	796	$\text{PI}_3 + \text{AsI}_3$	231
$\text{NiSO}_4 + \text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	212	$\text{P}_2\text{I}_4 + \text{I}_2$	1286
+ $\text{CaSO}_4 + \text{H}_2\text{O}$	677	$\text{P}_2\text{O}_3 + \text{BaO} + \text{H}_2\text{O}$	384
$\text{Ni}_2\text{SO}_4 + \text{CoSO}_4 + \text{H}_2\text{O}$	854, 5	+ $2\text{CoO} \cdot \text{P}_2\text{O}_5$	656
$\text{NiSO}_4 + \text{CuSO}_4 + \text{H}_2\text{O}$	990, 1	+ $\text{CaO} + \text{SiO}_2$	629
+ $\text{CuSO}_4 + \text{FeSO}_4 + \text{H}_2\text{O}$	977	+ $\text{Cr}_2\text{O}_3 + \text{H}_2\text{O}$	870
+ $\text{FeSO}_4 + \text{H}_2\text{O}$	1057	$\text{POCl}_3 + \text{Cl}_2$	787
$\text{NiSO}_3 + \text{Fe} \rightleftharpoons \text{FeSiO}_3 + \text{Ni}$	1006	$\text{POF}_3 + \text{BF}_3$	260
p-nitroanisole + HgCl_2	1229	$\text{PSF}_3 + \text{BF}_3$	260
Nitrobenzene.....	1165	Pentamite in H_2O , aq. H_3BO_3	502
+ AlBr_3	158	$\text{Pb} + 2\text{AgCl} \rightleftharpoons 2\text{Ag} + \text{PbCl}_2$	7, 78
+ $\text{AlBr}_3 + \text{CoCl}$	161	+ $2\text{AgI} \rightleftharpoons 2\text{Ag} + \text{PbI}_2$	7
+ $\text{AlBr}_3 + \text{LiCl}$	161	$2\text{Pb} + \text{Ag}_4\text{P}_2\text{O}_7 \rightleftharpoons 4\text{Ag} + \text{Pb}_2\text{P}_2\text{O}_7$	7
+ $\text{AlBr}_3 + \text{RbCl}$	161	$\text{Pb} + \text{Ag}_2\text{S} \rightleftharpoons 2\text{Ag} + \text{PbS}$	7
+ $\text{AlBr}_3 + \text{RbI}$	161	$3\text{Pb} + 2\text{BiF}_2 \rightleftharpoons 3\text{PbF}_2 + 2\text{Bi}$	426
+ AlCl_3 (+ NH_4Cl , NH_4Br , acetamide).....	174	+ $\text{Bi}_2\text{O}_3 \rightleftharpoons 2\text{Bi} + 3\text{PbO}$	426
+ AsBr_3	229	$\text{Pb} + \text{Cd}$ in $\text{CdBr}_2 + \text{PbBr}_2$	694
+ BiBr_3	426	+ Cd in $\text{CdCl}_2 + \text{PbCl}_2$	694
+ Co_2 (p-v).....	494	+ Cd in $\text{CdI}_2 + \text{PbI}_2$	694
+ $\text{H}_2\text{SO}_4 + \text{H}_2\text{O}$	1164, 5	+ $\text{FeS} \rightleftharpoons \text{Fe} + \text{PbS}$	1006
+ HgCl_2	1229	$\text{PbBr}_2 + \text{AgBr}$	18
o-Nitrobenzol + CO_2 (v.p.).....	484	+ AlBr_3	162
o-Nitronaphthalene + HgCl_2	1229	+ BiCl_3	431
Nitronaphthalene + HgCl_2 + urethan.....	1229	+ CdBr_2	702
o-Nitrotoluene + AlBr_3	158	+ $\text{CsBr} + \text{H}_2\text{O}$	874
m,p-Nitrotoluenes + AlBr_3	159	+ HgBr_2	1189
o-Nitrotoluene + AlCl_3	174	$\text{PbCl}_2 + 2\text{Ag} \rightleftharpoons 2\text{AgCl} + \text{Pb}$	7, 78
m,p-Nitrotoluenes + AlCl_3	175	+ AgCl	77
o,m,p-Nitrotoluene + HgCl_2	1229	+ $\text{Ag}_2\text{S} \rightleftharpoons \text{PbS} + 2\text{AgCl}$	78
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+ CO_2 (p-v).....	493	+ BiCl_3	431
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+ CO_2 + propane.....	489	+ $\text{CoCl}_2 + \text{KCl}$	597
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$\text{P} + \text{As}$	905	+ $\text{CdCl}_2 + \text{AgCl}$	78
+ Cu	1006	+ $\text{CdCl}_2 + \text{KCl}$	728
+ Fe	1006	+ $\text{CdCl}_2 + \text{TiCl}$	728
+ $\text{Fe} + \text{Al}$	1006	+ CoCl_2	818
+ $\text{Fe} + \text{Mn}$	1006	+ CsCl	885
$\text{PBr}_3 + \text{AlBr}_3$	162	+ CuCl	935
+ AsBr_3	230	+ FeCl_2	1016
$\text{PBr}_3 + \text{AsBr}_3$	230	+ FeCl_3	1029
$\text{PBr}_3 + \text{I}_2$	1286	+ HgI_2	1229
$\text{PBr}_3 + \text{I}_2$	1287	+ InCl_3	1296
$\text{PBr}_3 + \text{IBr}$	1288	$3\text{PbF}_2 + 2\text{Bi} \rightleftharpoons 3\text{Pb} + 2\text{BiF}_2$	426
$\text{PBr}_3 + \text{IBr}$	1288	$\text{PbI}_2 + 2\text{Ag} \rightleftharpoons 2\text{AgI} + \text{Pb}$	7

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+ Cu ₂ S.....	954	Quinine - IrCl ₃ , IrBr ₃ salts.....	1302
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Phenetole + GeCl ₄	1073	RbBr + CsF.....	889
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+ Ba(OH) ₂ + H ₂ O.....	382	RbCl + AgI.....	100
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+ Hg [II] acetate.....	1192	dRbCl · CdCl ₂ in H ₂ O.....	723
Phenyl hydrozine + H ₂ S.....	1159	RbCl + CdCl ₂ · 4RbCl + H ₂ O.....	723
Phosphate rock in H ₂ O.....	648	+ CoCl ₂ + H ₂ O.....	812
Phospho molybdic acid in H ₂ O.....	1152	+ CoSO ₄	856
Piperidine + H ₂ O ₂	1147	+ CsCl.....	885
Piperonal + H ₃ PO ₃	1148	+ CsCl + CaCl ₂	597
Piresonite in H ₂ O.....	547, 8	+ CsF.....	889
Pr. cnpls., see also Di.....		+ CsNO ₃ ⇌ CsCl + PbNO ₃	885
PrF ₃ + CsF.....	889	+ CuCl.....	935
Pr ₂ (SO ₄) ₃ + Cs ₂ SO ₄ + H ₂ O.....	901	+ HgCl ₂ + H ₂ O.....	1210
Propane + CO ₂ (p-v).....	490	Rb [Ca(NH ₃) ₂ (NO ₃) ₄] in H ₂ O, CH ₃ OH.....	833
+ CO ₂ + n-hexadecane.....	489	Rb ₃ Co(NO ₂) ₆ · H ₂ O in H ₂ O.....	835
+ CO ₂ + stripped crude oil.....	489	Rb ₂ Co(SO ₄) ₂ in H ₂ O.....	855
+ HF.....	1124	RbF + BeF ₂	409
+ H ₂ S.....	1160	+ CsBr.....	875
Propionic acid + HCl.....	1121	+ CsCl.....	886
Propionitrile + BeCl ₂	406	+ CsI.....	896
Propyl benzene + HBr.....	1105	Rb ₂ GeF ₆ in H ₂ O.....	1073

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RbI + AlBr₃ + C₆H₅NO₂	161
+ BiI₃ + H₂O	432
+ CsF	889
+ Hgl₂ + H₂O	1236
RbNO₃ + AgNO₃	123
+ CsCl \rightleftharpoons CsNO₃ + RbCl	885
+ CsNO₃	899
+ CsNO₃ + Ca(NO₃)₂	629
+ KNO₃ + Cd(NO₃)₂	744
Rb₂SO₄ + Ag₂SO₄ + H₂O	142
+ CaSO₄	687
+ CaSO₄ + H₂O	677
+ CdSO₄ + H₂O	760, 1
+ CaSO₄ + H₂O	855
ReCaCl₄ in H₂O , aq. H₂SO₄	884
Resacetophenone + H₃BO₃	282
Resorcinol + AsBr₃	230
+ Ba(OH)₂ + H₂O	382
Resorcylic aldehyde + H₃BO₃	282
S + As	229
+ AsI₃ + Iodoform	231
+ Bas	386
+ Bi	426
+ Bi + Co	790
+ Br₂	450
+ Cl₂	787
+ Co	790, 842
+ Co + Sb	790
+ Cs₂S₅	900
+ Cu	905
+ Cu + Ni	905
+ H₂S₂	1161
+ H₂S₃	1161
+ HgCl₂	1229
+ I₂	1287
+ I₂ + benzene , CS₂ , CCl₄ , bromoform	1285
+ Se + carbon disulfide	1285
S₂Br₂ + AsBr₃	230
Sulfur chloride + HCl	1121
Allyl Sulfur chlorides - HgCl₂ (double salts) In ether, aq. ether.....	1220
SO₂ + AlCl₃	177
+ BCl₃	256
+ BF₃	260
+ Br₂	449
+ Co₂ (p-v).....	494
+ Cl₂	787
+ Cl₂ + SO₂Cl₂	787
+ CsI	896
+ GeCl₄	1073
+ HCl	1121
+ HF	1124
+ H₂S	1161
+ organic vapors.....	1121
SO₂Cl₂	787
+ Cl₂ + SO₂	787
SO₃ + Al₂O₃ + H₂O	205-211
+ CrO₃ + H₂O	867-9
+ HNO₃ + H₂SO₄	1132
(SO₃)₂HNO₃ + H₂SO₄	1163
SO₃ + H₂O	1161, 2
+ H₂SeO₄	1171
SOF₂ + BF₃	260
SO₂N₂O₅·3H₂O + H₂SO₄	1163
Sb + As	229
+ Co + S	790
2Sb + 3FeS \rightleftharpoons 3Fe + Sb₂S₃	1006
Sb + I₂	1287
SbBr₂ + AlBr₃	162
+ AsBr₃	230
+ BiBr₃	426
SbCl₃ + AlCl₃	177
+ BiCl₃	431
+ CsCl in aq. HCl	884
2SbCl₃·3CeCl₃ in aq. HCl	884
SbCl₃ + HgCl₂	1229
+ I₂	1286
SbCl₃ + I₂	1286
SbI₃ + AsI₃	231
Sb₂S₃ + Cu₂S	964
Sb₂S₃ + Ag₂S	130
+ Bi₂S₃	438
+ CoS	790
+ 3Fe \rightleftharpoons 2Sb + 3FeS	1006
Sb triphenyl + Hg diphenyl	1194
Scorodite in aq. NaOH	1008
Se + Cu + CuSO₄	905
+ HgBr₂	1189
+ HgCl₂	1229
+ I₂	1287
+ I₂ + carbon disulfide	1285
+ S + carbon disulfide	1285
SeCl₄ + AlCl₃	177
SeO₂ + BaSeO₃ + H₂O	399
in H₂O	1168
+ H₂O	1169, 70
Si + As	229
+ 2FeO \rightleftharpoons 2Fe + SiO₂	1006
SiCl₄ + AsCl₃	230
+ Cl₂	787
SiO₂ + Al₂O₃ + H₂O	228
+ BaO	383
+ BaO + Na₂O	383
+ CaO	629
+ CaO + Al₂O₃	630
+ CaO + Fe₂O₃	630
+ CaO + Na₂O	630
+ CaO + P₂O₅	629
+ CaO + Na₂O + CO₂	630
+ CoO	841
+ FeO + Fe₂O₃	1038
+ FeO + FeS	1038
+ Fe + FeS + FeO	1006
+ 2Fe \rightleftharpoons 2FeO + Si	1006

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+ MgO + CaO.....	630	+ CdI ₂ + H ₂ O.....	736
+ TiO ₂ + CaO + CO ₂ + Na ₂ O + K ₂ O.....	556	+ CuSO ₄ + H ₂ O.....	996
SiS ₂ + Ag ₂ S.....	130	Syngonite in H ₂ O.....	553
SmF ₃ + CsF.....	889	Tartaric Acid + H ₃ BO ₃	282
Se + Cd in CdBr ₂ + SnBr ₂	694	d-Tartaric acid + H ₃ BO ₃ + H ₂ O.....	267
+ Cd in CdCl ₂ + SnCl ₂	694	Te + Cl ₂	787
+ I ₂	1287	+ I ₂	1287
SuBr ₂ + AlBr ₃	162	TeCl ₄ + AlCl ₃	177
SnBr ₄ + AlBr ₃	162	Ta ₂ Cr ₂ (SO ₄) ₄ · 24H ₂ O in H ₂ O.....	871
+ AsBr ₃	230	TeCoCl ₄ in aq. HCl.....	884
SeCl ₂ + AlCl ₃	177	TeGeF ₆ in H ₂ O.....	1073
SeCl ₄ + AlCl ₃	177	Tooth in aq. lactic acid (+ salts).....	548
+ AsCl ₃	230	Tetrahydro furan + GeCl ₄	1073
SnCl ₂ + CdCl ₂	728	Tetrahydro naphthalene.....	1105
SnCl ₄ + Cl ₂	787	cis-Tetrahydro naphthalene 1,2 diol + H ₃ BO ₃	279
SnCl ₂ + CoCl ₂	818	Tetrahydro pyran + GeCl ₄	1073
+ CuCl.....	935	Tetramethyl ammonium bromide + Br ₂	450
+ FeCl ₂	1016	+ Br ₂ + H ₂ O.....	445
Sol ₄ + AsI ₃	231	Tetramethyl ammonium [Co(NH ₃) ₂ (NO ₂) ₄] in H ₂ O.....	833
Sn tetraphenyl + Hg diphenyl.....	1194	Tetramethyl ammonium iodide + I ₂	1278
Soil phosphates in acid and base.....	647	+ toluene + I ₂	1283
SrBr ₂ + As ₂ O ₃ + H ₂ O.....	238	ThCl ₄ + CoCl ₂ + H ₂ O.....	813
+ BaBr ₂ + BaI ₂ + SrI ₂	298	Thionardite.....	676, 7
+ BaI ₂	363	Thioarea CdCl ₂ in H ₂ O.....	728
SrBr ₃ + InBr ₃ + H ₂ O.....	1293	Ti + B.....	255
SrCl ₂ + As ₂ O ₃ + H ₂ O.....	238	TiBr ₄ + AlBr ₃	162
+ BaCl ₂	353	+ AsBr ₃	230
+ BaCl ₂ + CaCl ₂	353	TiCl + AlCl ₃	177
+ BaO.....	383	TiCl ₄ + AlCl ₃	176
+ CaCl ₂	597	TiCl ₃ + AsCl ₃	230
+ CaCl ₂ + H ₂ O.....	588, 9	TiCl + BiCl ₃	431
+ CaCl ₂ + MgCl ₂ + KCl + NaCl + H ₂ O.....	587	TiCl ₄ + Br ₂	450
+ CaF ₂ ⇌ CaCl ₂ + SrF ₂	597	+ Cl ₂	787
+ CdCl ₂	728	TiCo ₂ F ₆ in H ₂ O, C ₂ H ₅ OH.....	889
+ CoCl ₂	818	TiO ₂ + CoO.....	630
+ CoCl ₂ + H ₂ O.....	812	+ CaO + Al ₂ O ₃ + H ₂ O.....	497
+ FeCl ₂	1016	+ SiO ₂ + K ₂ O + Na ₂ O + CO ₂ + CoO.....	556
+ HgCl ₂ + H ₂ O.....	1212	Tl + Br ₂	450
+ InCl ₃ + H ₂ O.....	1295	+ Cd in CdCl ₂ + Tl ₂ Cl ₂	694
SrF ₂ + BaCl ₂	353	+ Hg.....	1180
+ BaF ₂	360	+ I ₂	1287
+ CaCl ₂ ⇌ CaF ₂ + SrCl ₂	597	TlAl(SO ₄) ₂ in aq. Al ₂ (SO ₄) ₃ , Tl ₂ SO ₄	222
+ CaF ₂	603	in H ₂ O.....	222
SrI ₂ + BaBr ₂ + BaI ₂ + SrBr ₂	298	+ KAl(SO ₄) ₂ + H ₂ O.....	225
+ BaI ₂	363	+ NH ₄ Al(SO ₄) ₂ + H ₂ O.....	224
+ Hg(CN) ₂ · 6H ₂ O in H ₂ O, alc.....	1197	TlBr + AlBr ₃	162
+ InI ₃ + H ₂ O.....	1298	+ InBr ₃ + H ₂ O.....	1293
Sr(NO ₃) ₂ + AgNO ₃ + H ₂ O.....	111	TlCN · AgCN in H ₂ O.....	52
Sr(NO ₃) ₂ + Ba(NO ₃) ₂ + KNO ₃	377	2TlCN · Hg(CN) ₂ in H ₂ O, alc.....	1197
+ Ca(NO ₃) ₂ + H ₂ O.....	624	TlCl + AgCl.....	77
+ Ca(NO ₃) ₂ + NaNO ₃	629	+ AlCl ₃	177
SrO + CaCl ₂	597	+ BaCl ₂	353
Steel in milk.....	1006	+ BeCl ₂	406
Strychnine · IrCl ₃ , IrBr ₃ salts.....	1302	+ CaCl ₂	597
Succinonitrile + AgNO ₃ + H ₂ O.....	118	+ CdCl ₂	728
Sucrose + Ba(OH) ₂ + H ₂ O.....	381	+ CsCl.....	885
+ CaCl ₂ + H ₂ O.....	590	+ CsCl + H ₂ O.....	882, 3

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$\cdot 3\text{CsCl} \cdot 2\text{H}_2\text{O}$ in H_2O	883	$\text{UO}_2 + \text{CaO}$	630
$+ \text{CuCl}_2$	935	$\text{UO}_2\text{Ca}(\text{CO}_3)_3 \cdot 10\text{H}_2\text{O}$ in H_2O	556
$+ \text{FeCl}_3$	1029	$\text{UO}_2\text{C}_2\text{O}_4 + \text{BaC}_2\text{O}_4 + \text{H}_2\text{O}$	333
$+ \text{InCl}_3 + \text{H}_2\text{O}$	1296	$+ \text{CaC}_2\text{O}_4 + \text{H}_2\text{O}$	563
$+ \text{PbCl}_2 + \text{CdCl}_2$	728	Urea + CNNH_2	453
$\text{Ti}[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2] \text{ in } \text{H}_2\text{O}$	833	$+ \text{CO}_2 + \text{NH}_3$	484
$\text{Ti}[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_2\text{C}_2\text{O}_4] \text{ in } \text{H}_2\text{O}$	833	$+ \text{CoBr}_2 + \text{H}_2\text{O}$	505
$\text{Ti}_2\text{Cu}(\text{SO}_4)_2 + \text{K}_2\text{Cu}(\text{SO}_4)_2 + \text{H}_2\text{O}$	993	$+ \text{CoCl}_2 + \text{H}_2\text{O}$	590
$+ (\text{NH}_4)_2\text{Cu}(\text{SO}_4)_2 + \text{H}_2\text{O}$	993	$+ \text{Co}(\text{NO}_3)_2$	625
$\text{Tl} + \text{AgNO}_3 \rightleftharpoons \text{TlNO}_3 + \text{AgI}$	100	$+ \text{Co}(\text{NO}_3)_2 + \text{H}_2\text{O}$	625
$2\text{Tl} + \text{Ag}_2\text{SO}_4 \rightleftharpoons 2\text{AgI} + \text{Tl}_2\text{SO}_4$	100	$+ \text{CaSO}_4 + \text{H}_2\text{O}$	684, 5
$\text{Tl} + \text{InI}_3 + \text{H}_2\text{O}$	1298	$+ \text{H}_2\text{O}_2 + \text{H}_2\text{O}$	1147
$\text{TlNO}_3 + \text{AgI} \rightleftharpoons \text{AgNO}_3 + \text{TlI}$	100	Urethan + $\text{AlCl}_3 + \text{H}_2\text{O}$	169
$+ \text{AgNO}_3$	123	$+ \text{AsBr}_3$	230
$+ \text{AgNO}_3 + \text{KNO}_3$	123	$+ \text{CoCl}_2 + \text{H}_2\text{O}$	591
$+ \text{AgNO}_3 + \text{NaNO}_3$	123	$+ \text{HgCl}_2$	1229
$+ \text{AgNO}_3 + \text{KNO}_3 + \text{NaNO}_3$	123	$+ \text{HgCl}_2 + \text{nitronaphthalene}$	1229
$\text{TlNO}_2 + \text{Ba}(\text{NO}_3)_2 + \text{H}_2\text{O}$	370	$+ \text{HgCl}_2 + \text{p-nitrotoluene}$	1229
$\text{TlNO}_3 + \text{CdBr}_2$	702	VCs (SO_4) $_2$ in H_2O	902
$+ \text{Cd}(\text{NO}_3)_2$	744	$\text{V}_2\text{O}_5 + \text{CaO}$	629
$+ \text{CaNO}_3$	899	WO $_3$ + CsF	889
$+ \text{CaNO}_3 + \text{Cd}(\text{NO}_3)_2$	744	Xa + BF_3	261
$+ \text{HgBr}_2$	1189	p-Xylene + AlBr_3	161
$+ \text{HgCl}_2$	1229	Xylene + HBr	1105
$+ \text{Hgl}_2$	1243	o-Xylidine (as.) + Co_2 (v.p.).....	484
$\text{Ti}_2\text{S} + \text{Ag}_2\text{S}$	130	YF $_3$ + CsF	889
$+ \text{As}_2\text{S}_3$	242	$3\text{Zn} + 2\text{AlCl}_3 \rightleftharpoons 3\text{ZnCl}_2 + 2\text{Al}$	177
$\text{Ti}_2\text{SO}_4 + 2\text{AgI} \rightleftharpoons \text{Ag}_2\text{SO}_4 + 2\text{TlI}$	100	Zn + Bi	426
$+ \text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	222	$+ \text{Cd}$ in $\text{CdBr}_2 + \text{ZnBr}_2$	694
$+ \text{CdSO}_4 + \text{H}_2\text{O}$	761, 2	$+ \text{Cd}$ in $\text{CdCl}_2 + \text{ZnCl}_2$	694
$+ \text{Ce}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$	780	Zn · $\text{Bi}_2(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$ in conc. HNO_3	434
$+ \text{CoSO}_4 + \text{H}_2\text{O}$	856	ZnBr $_2$ + AlBr_3	162
$+ \text{CuSO}_4 + \text{H}_2\text{O}$	993	$+ \text{CdBr}_2$	702
$+ \text{CuSO}_4 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$	994	$+ \text{InBr}_3 + \text{H}_2\text{O}$	1293
$+ \text{CuSO}_4 + (\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{O}$	994	ZnCo nitrate.....	772
TISO $_4$ + HgBr_2	1189	$3\text{ZnCl}_2 + 2\text{Al} \rightleftharpoons 3\text{Zn} + 2\text{AlCl}_3$	177
$+ \text{HgCl}_2$	1229	ZnCl $_2$ + BaCl_2	353
$+ \text{Hgl}_2$	1243	$+ \text{BeCl}_2$	406
Toluene + $\text{AgClO}_4 + \text{H}_2\text{O}$	82, 83	$+ \text{BiCl}_3$	431
$+ \text{Cl}_2$	787	$+ \text{CaCl}_2$	597
$+ \text{HBr}$	1105	$+ \text{CoCl}_2 + \text{H}_2\text{O}$	590
$+ \text{tetramethyl ammonium iodide} + \text{I}_2$	1283	$+ \text{CdCl}_2$	728
o,m,p-Toluidine + AsCl_3	230	$+ \text{CoCl}_2$	818
Tolunitrile + BeCl_2	406	$+ \text{CoCl}_2 + \text{H}_2\text{O}$	813, 4
Trichloroacetic acid + H_3PO_3	1148	$+ \text{CuCl}_2$	935
$+ \text{H}_2\text{SO}_4$	1166	$+ \text{FeCl}_2$	1016
2,2,4 Trimethyl pentane + H_2	1095	$+ \text{FeCl}_3$	1029
Trimethyl phenyl ammonium iodide + I_2	1278	$+ \text{InCl}_3$	1296
Trinitrotoluene + AsBr_3	230	$+ \text{InCl}_3 + \text{H}_2\text{O}$	1296
$+ \text{AsCl}_3$	230	$\text{ZnC}_{12}(\text{SO}_4)_2$ in H_2O	902
$+ \text{BiBr}_3$	426	$\text{ZnF}_2 + \text{AgF}$	92
Triphenyl phosphine oxide + $\text{AsO}(\text{C}_6\text{H}_5)_3$	243	$\text{Zn}_3[\text{Gd}(\text{NO}_3)_6]_2 \cdot 24\text{H}_2\text{O}$	1071
$+ \text{As}(\text{C}_6\text{H}_5)_3$	243	$\text{Zn}[\text{Hg}(\text{SCN})_4] + \text{Cd}[\text{Hg}(\text{SCN})_4]$	708
Triphenyl phosphine sulfide + $\text{AsO}(\text{C}_6\text{H}_5)_3$	243	$\text{ZnHg}(\text{CNS})_4 + \text{CoHg}(\text{CNS})_4$	797
$+ \text{As}(\text{C}_6\text{H}_5)_3$	243	$\text{Zn}[\text{Hg}(\text{SCN})_4] + \text{Co}[\text{Hg}(\text{SCN})_4]$	708
Tripropyl amino + H_2O_2	1147	$+ \text{Cd}[\text{Hg}(\text{SCN})_4]$	708
UF $_6$ + HF	1124	$\text{ZnHg}(\text{SCN})_4$ in aq. NH_4Cl	1202, 3

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$\text{ZnI}_2 + \text{InI}_3 + \text{H}_2\text{O}$	1298	$+ \text{Cu}_2\text{S}$	964
$\text{ZnK}_2(\text{SO}_4)_2 + \text{CuK}_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	980	$+ \text{FeS}$	1045
$+ \text{FeK}_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	1054	$\text{ZnSO}_4 + \text{BeSO}_4 + \text{H}_2\text{O}$	424
$\text{Zn}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	987, 8	$+ \text{CsCl}$	885
$+ \text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 + \text{H}_2\text{O}$	1056	$+ \text{CuSO}_4 + \text{H}_2\text{O}$	995
$\text{Zn}(\text{NO}_3)_2 + \text{Cd}(\text{NO}_3)_2 + \text{H}_2\text{O}$	744	$+ \text{CuSO}_4 + \text{FeSO}_4 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$	977
$\text{ZnO} + \text{Cr}_2\text{O}_3 + \text{H}_2\text{O}$	871	$+ \text{H}_2\text{SO}_4$	1165
$\text{ZnO}_2 + \text{Cr}_2\text{O}_3 + \text{NiO}$	871	$+ 3\text{ZnO} + \text{CuSO}_4 \cdot 3\text{CuO} + \text{H}_2\text{O}$	974
$3\text{ZnO} \cdot \text{ZnSO}_4 + 3\text{CuO} \cdot \text{CuSO}_4 + \text{H}_2\text{O}$	974	$\text{ZnSiO}_3 + \text{CdSiO}_3$	763
$\text{ZnS} + \text{Ag}_2\text{S}$	130	Zr cupferrate	1177
$+ \text{CdS}$	747	$\text{ZrO}_2 + \text{BaO}$	383
$+ \text{CdS} + \text{MnS}$	747	$+ \text{CaCl}_2$	597
$+ \text{CdS} + \text{FeS} + \text{MnS}$	747	$\text{ZrO}(\text{oxalate}) + \text{Cs oxalate} + \text{H}_2\text{O}$	880